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One Hundred Years Ago

Elsewhere in this issue, we reproduce a section of a book, "English Trades," published in 1824, which at that time served the purpose of informing parents as to the prospects of each trade as a source of potential employment for the youth of the country. We discovered this book in the library of the Imperial Hotel, Barnstaple, whilst on holiday and we wish to express our indebtedness to the management for so kindly loaning it to us. It is a veritable mine of information on the industrial conditions of the era just prior to the introduction of the railways. It is apparent from both the illustrations and the descriptive matter that the cupola invented by Wilkinson was not in general use. It is no little matter for congratulation that the "founderies" which received publicity in those days are still in existence—and prospering to-day. A different story is to be told of a Mr. Brodie having an ominous address—at Carey Street—who attempted to make steel stoves, even though it is pointed out that these stoves were "of several hundred pounds value; and a more interesting sight cannot be well viewed, than the store rooms of our large furnishing ironmongers."

It is apparent that the moulder was regarded as being somewhat Bohemian in 1824, for in the chapter on the Brazier, it is stated "The founder requires a strong constitution to undergo the heat of the immense furnaces; he may earn thirty shillings per week, but it frequently happens that he spends a large proportion of it in porter."

The anonymous author of this book is particularly eulogistic about the machinist as the engineer was then called. He attributes the invention of the steam engine to the Marquis of Worcester who published his notes in 1663. The first machine was constructed in 1696 by Captain Savary, and was called the "Miners' Friend." Then in 1705 Newcomen and Crauly thought of applying a piston with a lever and "were contented to share the profits of the invention with Savary, who procured a patent for it in 1705. But it was not until 1712 that the difficulties in working it were removed. About 1762 Mr. Watt began to turn his attention to this machine, which he has since brought to so great a degree of perfection." It is worth quoting that the first engineering (machinists as it was then called) business to be established was that of Mr. Alexander Galloway, whose workshop was situated at No. 69, High Holborn.

Amongst the seventy trades dealt with, there are the Cutter, Brazier, Smith, Tinplate Worker and in all these a real insight is given to the prevailing state of the art after allowing for the inevitable lag due to the time necessary for compilation and publishing of a work of this character.

A Cheerful Review

Mr. Runciman's review of British trade to the House of Commons bears witness to the astonishing resilience of industry, and to the strength of a position of which we have daily experience. Coal and cotton are the only industries failing to come up to expectations. The decline in world trade appears to have been arrested, although the improvement is slight, and we have to rely mainly on internal trade for a continuance of recovery. Export trade is therefore less satisfactory than home trade. By all the indices to which the Board of Trade has access, it appears that the improvement is being maintained and Mr. Runciman was very optimistic regarding the immediate future. The country's share in world trade is increasing. He thought that iron and steel was our busiest important industry. There was, at last, a revival in shipbuilding. Exporters must look mainly to the Empire and to the sterling area. In the absence of major developments of a disturbing character abroad, and with industrial peace at home, there was every reason to hope that the progress of the last three or four years would continue.

He was inclined to think the influence of defence orders might be easily exaggerated. Naturally, from the purely economic point of view, defence orders are less satisfactory than ordinary trading, for the cost can only be met either by taxation or a defence loan, which would also increase taxation. Hence costs will tend to rise and hasten the peak of the prosperity cycle which heralds the next depression. The work has great value, apart from its primary object, in helping to dissolve the hard core of unemployment still remaining.

Another point of interest is the rapidly rising volume of imports, but the view of the President of the Board of Trade is that we can afford these imports and with that we have to be content. In three years no less than 24 trade agreements have been made with foreign countries, leading to an increase in exports of fourteen millions sterling in that period. Exports to Dominions increased, as did our imports from them. Altogether it was a heartening and cheering review, the more so when we look back to the depth of the depression.

Finishing of Die Castings*

By J. C. FOX

The finishing of die castings is very important from a sales and consumption standpoint. Not only must an article be finished for sales purposes, but the finish must be durable and lasting. The increasing uses of die castings during the past few years have created a demand for better finishing materials, better methods for finishing and inspection of the finish. These demands are being met.

Definite specifications for all types of finishes are gradually replacing the former promiscuous methods of finishing. Most large consumers of die castings now issue specifications covering the type of finish desired, the process to be used in finishing, and the quality of the final finish. To meet these specifications, the finisher must necessarily be more exacting and must carefully control every operation. Chemical control is now found in most large plating shops, and even some of the smaller shops have found it highly economical to maintain chemical laboratories and employ chemists to control the plating processes.

The purpose of this Paper is to present briefly a review of the present methods used in finishing zinc and aluminium alloy die castings. Only zinc-base and aluminium-base alloy die castings are considered, since these two alloys represent about 90 per cent. of all die castings consumed. Tin- and lead-base alloy die castings seldom are finished, because in most applications these alloys are used for their corrosion resistance and not for parts requiring decoration. The relatively new copper-base and magnesium-base alloy die castings are not yet of sufficient importance commercially to warrant discussion as to finishing.

Zinc-Base Alloy Die Castings

The standard zinc-base alloys used for die castings are those of the A.S.T.M. Tentative Specifications for Zinc-Base Alloy Die Castings (B 86 – 34 T).[1] Alloy No. XXI is composed essentially of 2.75 per cent. copper, 4 per cent. aluminium, 0.05 per cent. magnesium, and the remainder is zinc of special high grade (99.99 + per cent.). Alloy No. XXIII is practically the same as alloy No. XXI, with the exception that there is no copper in the alloy. Another alloy now being considered by Committee B-6 on Die-Cast Metals and Alloys, which is regularly used, has the same aluminium and magnesium contents and a copper content of 1 per cent.

It is due chiefly to the development of the special high-grade zinc that the consumption of zinc-base die castings has so greatly increased during the past few years. Properly formulated alloys made with this grade of zinc and other raw metals of highest purity are relatively stable, free from intergranular corrosion and structural changes. It is because of these properties that finishes applied to the present type of zinc alloy have greatly advanced in kind, quality and durability. Former zinc-base alloys were subject to rapid corrosion, deterioration and structural changes which greatly lessened the life of any finish applied.

Most zinc die castings are finished in a variety of ways, both for decoration and protection against tarnishing and surface oxidation. There are, however, many applications, in which zinc die castings are used in the natural as-cast state without any surface treatment. Such parts may be used for long periods of time without any effect on their general utility. It is only when appearance or sales appeal demands, that the present zinc die castings are electroplated or otherwise finished. The corrosion of the present high-purity zinc castings in moist atmospheres is moderate, as is shown by the 5-year exposure test programme conducted by Sub-Committee V, of Committee B-6, on Exposure and Corrosion Tests.[2]

The surface oxidation of zinc die castings may be inhibited by the application of a short dip in certain solutions of alkali chromates or bichromates. The New Jersey Zinc Company has developed an aqueous solution of sodium or potassium bichromate with an addition of a small amount of sulphuric acid. The film formed by dipping zinc die castings into such a solution for 10 to 15 sec. will resist any attack of moisture so long as the bichromate film remains. Zinc-base die-cast carburettors represent an instance of such treatment.

The majority of zinc-base die castings for motor vehicle uses are finished in bright nickel or chromium plate. For other uses, they are electroplated with other metals, japanned, enamelled, lacquered or finished with a combination of electroplate and enamel. Electric fan bases, clock cases and similar parts are finished in variously coloured enamels, with or without high-lighted sections, which may be either chromium plated or the plain zinc alloy polished to a high lustre. Polished zinc surfaces, not plated, may be protected against tarnishing by a final coat of a clear synthetic resin varnish. Realistic wood grain designs may be readily applied to zinc die castings as well as other novelty finishes of a great variety of colour, design and texture. Zinc die castings are also being coated with heavy deposits of celluloid mixtures by a dipping process.

Electroplating

Types of Plating.—Chromium plating, because of its tarnish resistance, high lustre and hardness, is the most popular finish applied to zinc die castings. Chromium can be applied directly to the metal, but such coatings are porous and lack the necessary protection for the base metal for outdoor exposure. It is common practice to deposit another metal directly to the base metal, which in turn is followed by a finishing coat of chromium. Nickel or the dual plating of copper and nickel have been found most suitable for deposition under chromium.

Extensive experimental work and practical service tests have shown that there is necessary a definite minimum thickness of deposit of this underlying protective metal for each type of application, environment and condition of use. There are at present three types of electroplated finishes most generally specified and used. The minimum thicknesses are shown below:—

	In.
(1) *Nickel-chromium plate:*	
Nickel plate	0.0003
Chromium plate	0.00001
(2) *Nickel-chromium plate:*	
Nickel plate	0.0008
Chromium plate	0.00001
(3) *Copper-nickel-chromium plate:*	
Copper plate	0.0003
Nickel plate	0.0003
Total copper and nickel plate	0.0008
Chromium plate	0.00001

The type of plating represented by Class 1 is the finish mostly applied to zinc die castings such as armaments, novelties and parts for interior use and not subject to excessive moisture and similar corrosive conditions. The heavier nickel plating represented by Class 2 is applied to zinc die castings subject to outdoor exposure and where a high quality plate is required. The copper-nickel-chromium plating is being used, like that of the Class 2, for parts requiring the maximum protection against severe corrosive conditions.

Preparation of the Metal Surface

There are two important factors which regulate the quality and durability of electrodeposited coatings on zinc die castings: namely, the condition of the surface of the die casting as produced and the proper preparation of the surface for electro-plating. The condition of the die casting surface as cast is very important. Die castings which are to be electroplated must be free from surface porosity, sponginess, deep run-marks, and other similar defects. More care in fabrication and closer inspection must be given die castings to be electroplated than for those parts which are to be otherwise finished. The casting conditions, such as gating, venting, pressure, metal and die temperatures must be carefully regulated and maintained to produce the maximum soundness of surface. No electroplated coating can be expected to cover over surface porosity and defects. Early failures of the plate usually result when attempts are made to coat over unsound sections.

Polishing.—Under good casting practice, it is possible to obtain smooth, sound, dense zinc die castings that require little grinding or polishing with coarse abrasives. Castings designed for electroplating finishes should be produced with surfaces sound enough that only a buffing with a rag wheel is required for the significant surfaces which are electroplated. The dense outer-surface characteristic of die castings should be maintained, if at all possible. Gated sections and parting lines necessarily have to be polished on an oil wheel, but on the remainder of the casting it should be only necessary to buff. Of course, this is not always possible, especially on large and intricately shaped castings, but every care should be taken to produce the best casting surface possible, as this has a bearing on the ultimate life of the finish.

The oiling operation is usually done on felt or canvas wheels, to which is glued emery of mesh varying from 140 to 180, depending upon the amount of surface to be removed. Buffing is done on a loose, sewed wheel with tripoli as the abrasive and at peripheral speeds of 5,000 to 6,000 ft. per min. Colouring is done with dry soft-cloth wheels using Vienna lime or a similar compound.

Cleaning.—The cleaning operations on zinc die castings prior to finishing are most important. The casting must be free from grease, buffing compounds, and there must not remain on the surface any film resulting from the cleaning operations. After the usual polishing and buffing operations, it is essential to clean the castings in an organic solvent to dissolve the binder in the buffing compounds, thereby loosening them for removal by the alkaline cleaning operation. Mechanical degreasing effectively removes all oil and grease and loosens the polishing compounds held in the recesses of castings. Following such degreasing treatment, the castings are cathodically cleaned in hot, mild alkaline solutions. Any of the numerous proprietary cleaning compounds can be used provided the concentration of the alkali is kept below the point where the zinc alloy is attacked and the surface discoloured. The alkalinity of the cleaning baths must be kept below a p_H value of 10, and the cleaning solutions should be checked and maintained daily by chemical analysis.

After suitable alkaline cleaning, the castings must be thoroughly rinsed free from alkali and then dipped into a weak mineral acid solution. Acid solutions such as 5 per cent. sulphuric, 5 + per cent. hydrochloric, or 1 per cent. hydrofluoric are regularly used for this operation. The acid-dip treatment tends to neutralise any free alkali not removed by rinsing, to dissolve any film left from the cleaning operation, and to produce a slightly roughened surface which aids adhesion of the subsequent plate.

Nickel Plating

In Table I the range of compositions of nickel plating baths most generally used and recom-

* A Paper presented as an Appendix to the Annual Report of Committee B-6 of the American Society for Testing Materials. The author is chairman of the sub-committee studying the subject, and is Chief Chemist and Metallurgist, Doehler Die Casting Company, Toledo, Ohio.

1 *Proceedings*, Am. Soc. Testing Mats., Vol. 34, Part I, p. 706 (1934); also 1935 Book of A.S.T.M. Tentative Standards, p. 369.

2 *Proceedings*, Am. Soc. Testing Mats., Vol. 35, Part I, p. 190 (1935).

mended for electroplating zinc-base alloy die castings are shown.

TABLE I.—*Recommended Compositions for Nickel Plating Baths.*

Composition.	Type A.	Type B.
Nickel sulphate, oz.	10 to 15	28 to 32
Ammonium chloride, oz. ..	2 to 3	None
Boric acid, oz. ..	2 to 3	4 to 5
Sodium sulphate, oz.	12 to 20	None
Nickel chloride, oz.	None	3 to 6
Water, gall. ..	1	1
p_H value—		
Electrometricly	4.9 to 5.7	5.0 to 5.3
Colorimetricly	5.4 to 6.2	5.5 to 5.8
Temperature ..	(Room to 29 deg. C.)	(43 to 49 deg. C.)
Current densities, amp. per sq. ft.	15 to 30	up to 60
Nickel content, oz.	2 to 3	5 to 6

The range of compositions shown under type A is typical of those plating baths regularly used for depositing nickel direct to the zinc-base metal. The high sodium-sulphate content permits good conductivity and high "throwing" power, thereby lessening the tendency towards formation of black streaking caused by the precipitation of spongy nickel by immersion. These baths have high efficiency and are relatively easy to control and maintain. Heavy nickel plates from these high sodium-sulphate baths are apt to be hard, brittle, and tend towards the formation of stress cracks in the plate.

The type of composition of nickel plating bath represented under type B is similar to the well-known O. P. Watts solution, and is used for depositing heavy nickel coats over a previous copper plate or over a nickel "strike" from the high sodium-sulphate bath. This type of solution is used warm, and the deposits resulting are soft and ductile. This solution permits the use of high current densities and deposits heavy nickel plates of desired thicknesses in a minimum time.

Bright Nickel.—A great deal of interest has been shown recently in the possibilities of using bright nickel-plating solutions for deposition of nickel of sufficient lustre, to eliminate the necessity for buffing or colouring prior to the deposition of other metals. There are several types of organic addition agents on the market. These added to a nickel plating bath of composition similar to the type B solution in small amounts yields a plate of high lustre. Up to the present only a limited experience has been had with these bright nickel solutions on zinc die castings, but there is a considerable amount of experimental work now being done with them.

Copper Plating.—The plating of copper direct to the zinc-base metal is complicated by the tendency of diffusion taking place between the copper plate and zinc-base alloy. The rate of diffusion is rapid for extremely thin deposits. Therefore, it is necessary to guard against thin deposits and always specify a minimum thickness of copper. It has been found that a thickness of 0.0002 in. of copper is satisfactory,[3] although it is the practice as a safety measure to specify a minimum thickness of 0.0003 in. Such copper deposits followed by a heavy nickel plate of a minimum thickness of 0.0005 in. will give excellent results provided, of course, that all precautions as to the plating procedure as outlined above are carefully observed.

Copper is plated most generally from a cyanide solution. A typical copper-plating solution has the following range of composition:—

Sodium cyanide, oz.	3 to 4
Cuprous cyanide, oz.	2 to 3
Sodium carbonate (soda ash), oz.	½ to 1
Roschelle salt, oz.	3 to 16
Water, gall.	1
Temperature	82 deg. C.
Current densities, amp. per sq. ft.	40 to 50

[3] W. F. Castell, *Transactions* (American) Electrochemical Soc., Vol. LXVI (1934).

The copper plate resulting from this type of solution is fairly bright and does not require buffing or colouring prior to the deposition of nickel.

Schedule of Operations.—The following is a typical schedule of operations performed in the electroplating of zinc die castings:—

(1) Remove parting lines by grinding with 120- to 160-mesh emery glued on a felt or rag wheel, with a speed of wheel of 2,200 r.p.m.

(2) Polish with 180-mesh emery on a greased felt or rag wheel at 2,200 r.p.m.

(3) Buff on loose-stitched or bias-sewed canvas wheel using Tripoli at 2,200 r.p.m.

(4) Degrease in a vapour-phase degreaser using trichlorethylene.

(5) Clean in a suitable mild alkaline cleaner, electrolytically at 93 deg. C., making the article the cathode at 6 v. and passing enough current to cause vigorous gassing for over 1 min. Any of the common cleaning preparations of concentrations of 2 to 4 ozs. per gall. may be used.

(6) Rinse thoroughly in clear running water.

(7) Dip in cold 1 per cent. hydrofluoric or 5 per cent. sulphuric acid solution for about 30 sec. Rinse in water.

(8) Plate in copper bath, current density and time being regulated to produce a plate of minimum thickness of 0.0003-in. copper.

(9) Rinse in water.

(10) Dip in 5 per cent. sulphuric acid solution, rinse.

(11) Plate in nickel bath (type B) using sufficient current density and time to produce a plate of minimum thickness of 0.0005-in. nickel.

(12) Rinse first in cold then hot water, dry.

(13) Colour buff nickel plate using Vienna lime at 2,200 r.p.m.

(14) Clean in alkaline electrolytic cleaner.

(15) Rinse in water, acid dip and again rinse in water.

(16) Plate in chromium solution.

The schedule for plating direct with nickel is the same as above up to operation 7, after which the article is plated in type A plating bath with a minimum of 0.0003-in. nickel and the balance of the operations followed.

Other Plated Finishes.—In addition to the plated finishes described above, zinc-base die castings may be finished in bronze, silver, gold, and other similar metals. In finishing with these metals it is only essential that a primary coat of nickel of minimum thickness of 0.0001 in. be deposited before electroplating. With this procedure durable finishes will be obtained.

Control of Plating.—Chemical control of the plating room is the best means for securing good uniform deposits of metal. A suggested schedule for the control of plating solutions follows:—All acid dipping solutions should be analysed every day for acid content. All alkaline cleaners should be checked for carbonate and hydroxide content every day. The copper solutions should be analysed once a day for copper content, free cyanide and carbonate content. Nickel solutions should be checked twice a week for nickel content, chloride content, sulphate content and boric acid. The p_H value of all nickel solutions should be determined twice a day. Chromium solutions should be analysed at least once a week for chromic acid-sulphate ratio. The chromium content should be determined every day. Additions to the plating solutions should be made immediately upon receiving the analysis. In addition to the above, the thickness of copper and nickel on plated articles should be determined every day. The thickness tests can be arranged so that every piece will have been checked for thickness each week.

To determine the thickness of plating, saw off a sample and fasten it in a clamp so that the surface to be polished will be at right-angles to the plated surface. Grind on 120-mesh emery paper until saw marks have been removed. Polish on emery paper No. 1 at right-angles to marks left by emery of 120 mesh until scratches have been removed. Polish on emery papers Nos. 0 and 00 in the same way. Polish finally on a broadcloth wheel rotating at 1,700 r.p.m. using polishing alumina. Wash off surface between each polishing operation. Etch the sample with $NH_4OH \cdot H_2O_2$ etching solution. Place the sample under a microscope and by means of the scale in the eyepiece, determine the thickness. Three or four samples can be examined at one time by clamping them together. This method is essentially the same as that described by C. E. Heussner,[4] who has done a great deal to further the methods and control of electroplating of die castings.

Organic Finishes

Zinc-base die castings are capable of being finished in a wide variety of organic finishes and combinations of finishes, which are used primarily for decoration and sales appeal. For this purpose, there is available an endless range of colours and textures in lacquers, enamels, japans and varnishes. Combinations of lustrous chromium plate with variously coloured enamels are being used effectively. Another attractive arrangement is to assemble bright chromium-plated zinc die castings with coloured plastics, either of the phenolic or cellulose acetate type. For most applications where enamel finishes are employed, the alloys are not used under conditions of severe outdoor exposure, although some types of finishes are capable of such use.

The newer types of baking synthetic resin enamels have almost wholly displaced the use of air-drying pyroxylin lacquers for zinc-base die castings. These new finishes have excellent properties in abrasion resistance, impact strength and extensability. They have unusual adhering qualities, high gloss and are capable of resisting the action of strong chemical solution, gasoline, oils and the like. They are usually sprayed over surfaces, which have previously been properly prepared and primed, and are then baked at relatively low temperatures for short intervals of time. The heat of the baking operation changes the resin chemically and makes the finish resistant to heat and insoluble in various media. The baking also aids in binding the enamel to the base coating.

There is little that is standard in the formulation of enamels and lacquers, and compositions vary widely. Each manufacturer has his own particular formula for a given type of finish. For the choice of suitable materials it is, therefore, best to rely upon the integrity and experience of the manufacturer to supply material that is consistently uniform and fulfills all requirements, and to follow the advice and recommendations that he has to offer.

Preparation of the Metal Surface.—As with most finishes on metals, the preparation of the metal surface for the application of organic finishes is most important in the ultimate "life" of the coating. Failure to recognise this may be responsible for poor results. The improved knowledge of the technique of pretreatment of metals for finishing has been a large factor in the increased use and durability of organic finishes on zinc die castings.

To obtain the best results, there are three factors which must be closely observed in the preparation of the metal surface:—

(1) The metal surface must be thoroughly cleaned free from oil, grease, alkali films and other foreign matter. The choice of the method of cleaning depends upon the nature of the dirt or film to be removed. If an oil film from a previous machining operation is the only foreign matter present, a simple dip in an organic solvent such as carbon tetrachloride, trichlorethylene or similar solvent may suffice to produce a surface clean enough for subsequent treatment. However, cathodic cleaning in a mild alkaline solution such as outlined in the electroplating procedure is relied upon, and is generally most

[4] C. E. Heussner, "Microscopic Measurement of Electroplated Deposits," Monthly Review, Am. Electro-Platers' Soc., January, 1936.

effective and economical for cleaning of the metal surface.

(2) The work surface should preferably be roughened or etched to provide anchorage and to increase adhesion of the primary coating. Sand blasting, where available, with a fine sand is effective for this purpose, and also serves as an excellent means for cleaning the surface. Etching by chemical means after a previous cleaning operation will also produce a roughened surface. For this, there are several acid solutions which are regularly used: 5 to 10 per cent. hydrochloric acid solution, 1 per cent. hydrofluoric acid solution; or 3 per cent. solution of orthophosphoric acid may be used with a dip of 20 to 30 sec. followed by a thorough rinsing and drying. There are several proprietary solutions on the market which can be used for this purpose with good results.

(3) The use of a suitable priming material applied directly on the base metal is advisable for inhibiting corrosion, insulating the metal surface, resisting penetration by moisture, and acting as a base for succeeding finishing coats. A good primer material properly applied and baked is more important in promoting successful protection of the metal than the quality of finishing coats. Chromate and iron oxide primers suspended in a good synthetic resin vehicle will show excellent corrosion inhibiting qualities. Powdered aluminium in a synthetic resin vehicle can also be used as a primer material for zinc and aluminium die castings.

Enamelling.—A typical procedure for enamelling zinc die castings is as follows:—(1) Clean casting; (2) sand blast or acid etch; (3) apply primer coat; (4) bake primer at about 150 deg. C. for 1 hr.; (5) apply synthetic resin enamel colour coat; (6) bake enamel; and (7) add additional colour coats as required.

The method of finishing naturally depends to a great extent upon the use and environment to which the article is to be subjected. Some parts, which are not subject to much handling, such as clock cases and ornaments, may require only a good sand blasting and a finishing coat applied without a primer underneath. There are some makes of enamel which can be applied in one coat over a sand-blasted or etched die-cast surface, and which give excellent results. However, a part such as a telephone receiver or base which is handled a great deal requires the best preparation of the surface and a number of finishing coats of enamels to obtain long life.

Combination of Chromium Plate and Enamel.—Some synthetic resin materials are capable of being buffed after baking. Advantage of this is taken in the finishing of ornamental zinc die castings where chromium plate is part of the finish. Such buffing enamels may be applied to the part, baked, the high-lighted parts pumiced, and then such high-lighted parts chromium plated in the regular procedure, without effecting the adhesion of the enamel. Of course, this procedure is used only when there is a large surface to be enamelled and only a small section to be plated.

When the reverse is the case, that is, when the electrodeposited coating is the major finish, and only a small section is to be enamelled, it is the practice to apply such enamels after first electroplating, and either air dry or bake them at a low temperature. Above temperatures of 120 deg. C. there is a tendency towards blistering of the plating. For this type of finish, the heavy copper-nickel-chromium plating is preferred, since this plating, if properly applied over a sound surface, withstands baking temperatures up to 120 deg. C. more satisfactorily than the direct nickel-chromium coatings.

Selection of Alloy.—For finishing zinc die castings with materials which require the application of heat, some consideration must be given to the composition of the alloy because of the difference in behaviour of the standard alloys under heat. A.S.T.M. alloy No. XXI with approximately 3 per cent. copper is subject to greater loss of strength, ductility and shock resistance under heat than is alloy No. XXIII with no copper or the alloy having 1 per cent. copper. Therefore, for baked finishes, it is recommended that either of the latter two alloys be used in preference to A.S.T.M. alloy No. XXI. These alloys will withstand temperatures up to 175 deg. C. for 2 hrs. without any deleterious effects on their physical properties.

Evaluation of Organic Finishes.—There are now available physical test procedures for determining the quality and durability of organic finishes. Details of these tests are set forth in Papers by Schuh and his associates,[5] who have done excellent work in the development of tests for the quantitative measurement of durability and serviceability of finishes on metals.

Aluminium-Base Alloy Die Castings

The standard aluminium base alloys used for die castings are essentially those covered by A.S.T.M. Tentative Specifications for Aluminium-Base Alloy Die Castings (B 85 – 33 T).[6] These alloys, seven in number designated alloys Nos. IV, V, VII, VIII, IX, XI and XII, may be classified into three main groups:—(1) Copper-aluminium alloys; (2) copper-silicon-aluminium alloys, and (3) silicon-aluminium alloys. Light weight, corrosion resistance, ability to take and hold a high polish, and high thermal and electrical conductivity are the desirable properties for which aluminium die castings are noted.

Aluminium die castings are most generally finished by polishing, enamelling and anodically oxidising and colouring. They are seldom electroplated, although this treatment is possible. Special technique and care must be exercised to produce adherent electroplated deposits. The chief difficulty in the electroplating of aluminium-base alloys is in obtaining deposits which will not peel, flake or blister in service. This may be overcome by introducing into the plating procedure a strong acid etch prior to the plating operation. Nickel is used most generally as a primary plate. If a good adherent nickel plate can be deposited, chromium, copper, silver, gold and other metals may then be satisfactorily deposited over the nickel. Chromium and zinc can be deposited directly on aluminium-base materials, but such coatings are not very resistant to corrosive conditions.

Polishing

Polished aluminium die castings retain their lustre for long periods of time under ordinary atmospheric conditions. It is because of this that most applications of aluminium die castings are finished simply by polishing and buffing to a high lustre. The degree of lustre obtained on polishing depends to some extent upon the density of the metal surface. The characteristic dense outer structures found in die castings as a result of the rapid chilling effect promotes high lustre in polishing. The usual operations for polishing aluminium die castings to produce a brilliant finish are as follow: —

(1) *Rag Wheel Operation.*—This operation employs a wheel made up of buffs to which is glued powdered emery 80 to 120 mesh, with a speed of wheel of about 2,500 r.p.m. This operation removes deep scratches, pits, run-marks, etc.

(2) *Oiling Operation.*—For this operation, a solid wheel coated with a finer emery of 140 to 180 mesh is used at about the same speeds as the previous operation.

(3) *Buffing Operation.*—For buffing, the wheel is made up of sewed buffs, the size and shape being determined by the article being treated, with speeds of about 2,600 r.p.m.

(4) *Colouring Operation.*—The colouring operation gives to the article a bright mirror finish as a final operation in polishing. It is conducted usually with a 12-in. wheel made up of sections of sewed buffs revolving at a speed of 2,000 r.p.m. Vienna lime or similar colouring material are used on the wheels.

Aluminium die castings are also finished in a satin or frosted finish, produced by scratch brushing or by using powdered pumice on the polishing wheels. Ball burnishing is another method regularly used for brightening aluminium surfaces. Still another polishing effect known as "Sun-Ray" finish is applied in certain cases, as for example to the inside surfaces of cooking utensils.

Another white frosted finish which is somewhat different in appearance to that obtained by scratch brushing or pumicing, is produced by a strong alkali and strong acid treatment. This treatment, which is used quite extensively for waffle moulds, cooking grills and utensils, is briefly described as follows:—

Acid-Dip Treatment

The casting is dipped into a strong hot solution of caustic soda (1 to 2 lbs. caustic soda per gall. of water heated to 82 deg. C.) until a uniform blackening of the whole casting takes place. It is then rinsed thoroughly in water and then dipped into a strong acid mixture (3 parts concentrated nitric acid, 1 part concentrated hydrofluoric acid) held at room temperature until all the black smudge is dissolved and the casting assumes a white frosted finish throughout.

Enamelling and Japanning

Japan, an oil enamel made up of gilsonite dissolved in solvents and drying oils, is used quite extensively for finishing many aluminium die castings. The general process is to remove the solvents by heat, and fuse until a uniform hard layer is formed, producing a tough durable finish. Two or three coats are usually applied, the surface being sanded and polished between coats. The cost of the material and process is relatively low and, when properly applied, the finish is durable. Sewing machine, adding machine, and typewriter parts and similar aluminium die-cast parts have japan finishes.

The newer synthetic resin enamels are, however, gradually replacing the japan finish for many parts. This is chiefly due to the superior abrasion and impact resistance and other properties that some of the synthetic enamels possess. The procedure for enamelling as outlined for zinc-base die castings can readily be used for aluminium die castings.

Anodic-Oxidation Treatment

One of the methods for finishing aluminium die castings which is gaining rapidly in popularity is the anodic-oxidation treatment. By this process, relatively heavy coatings of aluminium oxide are artificially deposited by electrolytic means. As is well known, there is always present on the surface of aluminium-base metals a very thin natural film of aluminium oxide. This film protects the base metal from attack of corrosive media and is responsible for the ability of aluminium to hold a high polish without tarnishing. Were it not for this protective oxide film, aluminium and its alloys would not have the corrosion resistance they possess. By special means, heavy oxide coatings of approximately 0.0004 in. in thickness can be produced artificially on aluminium surfaces. The best means for accomplishing this is by the anodic oxidation process, which consists in making the article to be treated the anode in a suitable electrolyte with a lead-lined tank as the cathode. The work is fastened to pure aluminium racks.

Although there are a number of electrolytes suitable for this treatment, the so-called "Alumilite" process, employing a sulphuric acid solution of approximately 25 per cent. strength, is commonly used because of certain

5 A. E. Schuh, "Evaluation of Industrial Finishes," *Industrial and Engineering Chemistry*, Vol. 23, December, 1931, pp. 1346–1352.
A. E. Schuh and W. Kern, "Measurement of Abrasion Resistance," *Industrial and Engineering Chemistry*, Analytical Edition, Vol. 3, January 15, 1931, pp. 72–76.
A. E. Schuh and H. C. Theurer, "Physical Evaluation of Finishes," *Industrial and Engineering Chemistry*, Analytical Edition, Vol. 6, March 15, 1934, pp. 91–97.

6 *Proceedings*, Am. Soc. Testing Mats., Vol. 33, Part I, p. 641 (1933); also 1935 Book of A.S.T.M. Tentative Standards, p. 362.

economies and its general practicability. With the voltage, current density, temperature, and other variables carefully regulated, an extremely tenacious oxide coating is produced which is resistant to moisture, salt solutions, and other corrosive substances. This oxide film is formed of the metal itself and will not chip or flake and is extremely hard and wear resistant. Further, it is quite absorptive, being capable of taking on certain types of aniline dyes and mineral pigments permitting a great variety of coloration. The dyeing of the oxide is done after the oxidation treatment; the article while still on the racks is immersed in a hot aqueous solution of a suitable dye for about 10 min., after which it is removed, rinsed, then dipped into a chemical solution for sealing, and dried. The dyed coating may then be given a very light buffing operation to bring out the lustre.

With mineral pigments the range of colours is not so great as with aniline dyes, but they are more durable and fast. They are usually formed by precipitation such as, for instance, chrome yellow, which may be formed by first dipping the oxide coating in a solution of lead acetate followed by a dip into a soluble chromate solution.

The character of the finished anodically-treated article is influenced by the condition of the surface of the article prior to treatment. If a lustrous finish is desired, the article must first be polished. If a matt effect is required, the article may be first sand-blasted before anodising. Anodic treatment direct on the die-cast surface, as cast, results in a dull oxide coating.

Selection of Alloy

Protection against staining, corrosion and wear can be given any of the standard aluminium casting alloys. There are, however, some restrictions relative to the alloy most suitable in casting qualities and also for service. When the final appearance of the aluminium die casting after oxidising is important, the influence of various alloying constituents must be carefully considered.

In the following table the standard A.S.T.M. aluminium die-casting alloys of the Tentative Specifications for Aluminium-Base Alloy Die Castings (B 85 – 33 T)[7] are grouped in order of choice for the anodic-oxidation treatment:—

Order.	Colour after oxidising.	Casting qualities.	Abrasion resistance.	Corrosion resistance.	Current requirements.
1	VIII	V	VIII	VIII	V
2	XII	XI	IV	IV	IV
3	IV	XII	XI	V	XI
4	XI	IV	V	XI	VIII
5	V	VIII	XII	XII	XII

These selections are based on average results. The order of selection of colour is determined by the degree of darkening which takes place in the oxidation treatment. In most alloys, silicon over 1 per cent. affects the colour. The high-silicon alloys darken badly and are placed at the bottom of the list. Alloy No. VIII gives the lightest in coloured oxide. Alloy No. VIII also produces the best combination of hardness and abrasion resistance. Its casting qualities, however, are relatively poor and its use is confined to small and simple-shaped castings.

Alloy No. IV (5 per cent. silicon) produces an oxide coating which has good abrasion and corrosion resistance, but the grey appearance may be objectionable for some uses. Alloy No. V is the best all-round casting alloy, but it produces an oxide coating which is excessively dark in colour and low in abrasion resistance. Alloy No. XII, which is used as a general purpose alloy for die casting, offers a broad scope for coloured oxide work. It has fair casting qualities and fair colour

(*Concluded in next column.*)

[7] *Proceedings*, Am. Soc. Testing Mats., Vol. 33, Part I, p. 641 (1933); also 1935 Book of A.S.T.M. Tentative Standards, p. 362.

International Foundry Congress in Düsseldorf

PRELIMINARY PROGRAMME

As previously announced, the next International Foundry Congress will be held from September 16 to 20, 1936, at Düsseldorf.

The opening of the Congress and Technical Foundry Exhibition will be on Wednesday, September 16, at 11 a.m., followed by a tour of the exhibition and the inaugural luncheon.

THURSDAY, SEPTEMBER 17, TO SATURDAY, SEPTEMBER 19.

Mornings.—Papers will be read in two simultaneous sessions. A list of Papers is given below.

Afternoons.—Visits to industrial works in Rhenish-Westphalian industrial region.

Papers.—All Papers read at the Congress will be published in a commemorative volume of three parts:—

(*a*) Papers dealing with general foundry practice.

(*b*) Papers dealing with the metallurgy of iron and steel castings and malleable cast iron.

(*c*) Papers dealing with non-ferrous castings.

Each part will be sold separately.

Registration.—To attend the Congress, registration cards can be obtained on payment of the following fees:—

(*a*) For members of associations affiliated to the international committee, 10 R.M.

(*b*) For non-members of these associations, 12 R.M.

Ladies attending the Congress will not be required to pay fees.

The cards admit to all the meetings and functions, including the exhibition.

Registration cards available for one day only will also be issued at 5 and 6 R.M.

Commemorative Volume.—The price of the commemorative volume has not yet been fixed, but the total cost will not exceed 10 R.M.

Post Congress Tour

From September 23 to October 7, a comprehensive tour of Germany has been arranged. It will be effected by motor coaches, and will include visiting works in the following cities and towns:—Frankfort, Darmstadt, Mannheim, Heidelberg (two nights), Karlsruhe, Pforzheim, Stuttgart, Urach, Ulm, Augsburg, Munich (two nights), Nürnberg (two nights), Bayreuth, Plauen, Chemnitz, Freiburg, Dresden, Meissen, Leipzig, Wittenberg, Potsdam and Berlin.

The beginning of the tour includes travelling by the Westerwald to Coblence, from which town a boat is taken to Assmannshausen. The inclusive price for this 15-day tour is 268 R.M.

List of Papers expected to be Read

I.—Papers dealing with General Foundry Practice.

1.—"Cast Iron and its Present Position as a Structural Material," by Prof. Dr.-Ing. Thum, Darmstadt.

2.—"Foundry Technology as a Preliminary Study in the Training of Constructional Engineers," by Prof. Dr. Kessner, Karlsruhe.

3.—"Modern Statistical Works Control in Foundry Practice," by Dr. Herbert Antoine, Berlin.

4.—"What Practical Demands can be placed on the Moulding Machine," by Prof. Dipl.-Ing. U. Lohse, Jena.

5.—"Influence of the Compression of the Moulding Material on its Properties" (Czecho-Slovakian Exchange Paper), by Prof. Dr. mont. Pisek and Ing. Homann, Brünn.

6.—"Contribution to the Action of Bond in Moulding Sand," by Dr.-Ing. Schneider, Clausthal.

7.—"Standardisation of Methods for Testing Moulding Sands" (Belgian Exchange Paper), by Fr. Bousseau, Liège.

8.—"New Methods for Testing the Grain Size of Moulding Sand" (Polish Exchange Paper), by C. Gierdziejewski and W. Gorycki.

9.—"Oil Cores and their Testing," by Prof. Dr.-Ing. Nipper, Aachen.

II.—Papers dealing with the Metallurgy of Iron and Steel Castings and Malleable Cast Iron.

10.—"Metallurgical Principles in the Manufacture of Foundry Iron in the light of a New Smelting Process with Special Reference to Desulphurisation Reactions," by Prof. Dr.-Ing. Paschke, Clausthal.

11.—"Structure of Cast Iron" (British Exchange Paper), by J. G. Pearce, Birmingham.

12.—"Impact Strength of Cast Iron," by Prof. Dr.-Ing. Piwowarsky, Aachen.

13.—"Wall-Thickness Sensitivity of Cast Iron," by Dr.-Ing. Jungbluth, Essen.

14.—"Surface Characteristics and Properties of Cast Iron," by Prof. Diepschlag, Breslau.

15.—"Mechanical Properties of Grey Cast Iron in Relation to Wall-Thickness and its Position in the Cast-Iron Diagram," by Prof. Dr.-Ing. Uhlitzsch, Freiberg.

16.—"Effect of Tensile and Compressive Stresses on the Graphite and Phosphide Eutectic," by Dr.-Ing. Bischof, Clausthal.

17.—"Present State of Technology Regarding the Manufacture of Heat-Resisting Castings in France" (French Exchange Paper), by A. Le Thomas, Saulnes, France.

18.—"Casting Stresses in Chilled Castings" (American Exchange Paper), by J. Erler, Ansonia, Conn., U.S.A.

19.—"Corrosion-Resisting High-Silicon Cast Iron" (Italian Exchange Paper), by Dr. Raoul Dupuis, Milan.

20.—"Physical Properties of High-Alloy Chrome Cast Irons," by Dr.-Ing. Roesch, Remscheid.

21.—"Casting of High-Duty Steel Castings," by Dr.-Ing. Pölzguter, Bochum.

22.—"Experiences with High-Frequency Furnaces," by Dr.-Ing. Dr. mont. Broglio, Ründeroth.

23.—"Grading and Testing of Cast Iron on Modern Principles" (Austrian Exchange Paper), by Dr.-Ing. G. Meyersberg.

III.—Papers dealing with Non-Ferrous Castings.

24.—"New Trend of Developments in the Manufacture of Light Alloy Castings," by Dr. Linicus, Düsseldorf.

25.—"Development Since 1933 and Present Position of Non-Ferrous Alloys in Germany," by Dr.-Ing. W. Claus, Berlin-Steglitz.

26.—"Kinetics of Oxidation Reactions in Molten Metals (Zinc, Lead, Silver and Copper)" (Polish Exchange Paper), by Prof. Dr.-Ing. Krupkowski and Ing. S. Balicki.

27.—"Properties, Uses and Manufacture of Lead Bronzes," by Foundry-Engineer Höhne, Leipzig.

28.—"Cylinder Heads of Light Metal Castings," by Dr. Nitsche, Nürnberg.

29.—"Considerations on the Use of Waste and Scrap in Aluminium Foundries," by Dr. Irmann, Neuhausen (Switzerland).

30.—"Hydronalium and Electron," by Dr. Schultze, Bitterfeld.

(*Concluded from previous column.*)

of the oxide after the anodic treatment which is capable of being dyed in any but the light shades.

The cost of application of the anodic oxidation coating is about the same as the cost of electroplating with nickel. Of course, this will vary with the size, shape and the desired finish, but generally it is relatively an inexpensive finish.

Ironfounding as a Career in 1824

This article, which is taken from "English Trades" (12th Edition), published in 1824, was written with the object of giving parents an insight into the various crafts when engaged upon the determining of a suitable trade to which to apprentice their sons.

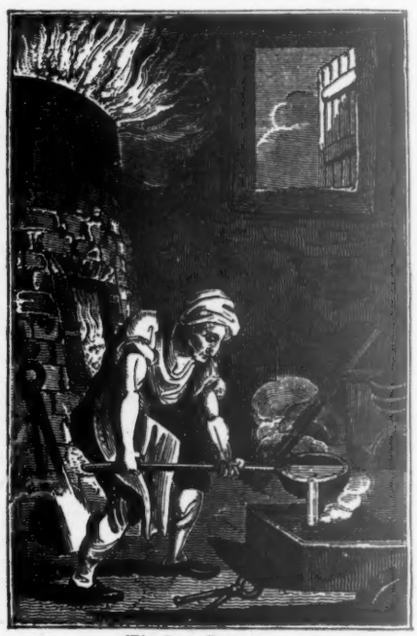
The Ironfounder

The art of founding in metal, or of melting it and forming it into various shapes, now occupies a space in our wants, which entitles it to considerable attention.

If the Greeks, and after them the Romans, perfected it as far as refers to casting in brass and bronze, we have extended it more than they did, inasmuch as we have turned it to all the great features of general utility.

Iron is the staple commodity in the modern foundery. The great abundance of this metal, with its consequent cheapness, together with the developments of chemistry, have, amongst us, opened to it a field, and created for it a demand, the extent of which is, at present, absolutely incalculable.

It is generally believed that cannon have been made use of in Europe ever since the year 1338, and that they were employed for naval



The Iron Founder.

FIG. 1.

purposes in the Baltic Sea in 1350; at any rate, it is certain that they were used by the Venetians in 1366, at the siege of Claudia Jessa. Lamey ascribes the invention of brass cannon to J. Owen; he asserts there were none such known in England till the year 1535, and that iron cannon were for the first time cast in this country in 1547. Specimens of great guns, as they were first used, and before the casting of them in founderies came into use, are still to be seen in many parts of Europe, and some, also, in the Tower of London and at Woolwich.

The uses to which cast iron was applied, previously to the last century, are, comparatively, of trivial importance; it now enters more or less into the materials of almost every manufactory, forming wheels, cylinders, pipes, arches, grates, stoves and innumerable other appendages and implements, without which the mechanic would be almost undone, and the domestic concerns of mankind would suffer considerable disadvantage and inconvenience. If value be estimated by utility, iron is unquestionably the most valuable of the metals, for, in addition to its use in the various arts of life, it is perfectly harmless in its effects upon the human constitution when taken either in its crude state or in the form of oxide or rust, unless in immoderate quantity; a quality which few, if any, of the other common metals possess.

Iron is employed in three states, each having peculiar properties, by which it is applicable to various purposes; the first is *cast-iron*, the second *wrought* or malleable iron, and the third is called *steel*.

Our business at present is with the cast-iron manufactory, of which we have a representation in the plate; the Founder has just taken from the furnace a ladle full of liquid metal, with which he is going to cast, perhaps, the front of a stove, or some other article the form of which is moulded out in stiff sand. It will be readily conceived that this business requires great strength and a constitution that will bear a vast degree of heat.

Iron is dug out of the earth in the form of stones, and in this state it is called ore. The richest ores, that is, those which yield most pure metal, are heavy, and of a brownish colour inclining to red.

Before the metal is extracted, the ore is sometimes roasted or calcined; this is done by a different process in different places: at the iron works in Staffordshire, after the ore is dug, they calcine it in the open air with small charcoal, wood or sea-coal, in order to break it in small pieces. This process requires three days. But at the Forest of Dean, in Gloucestershire, the ore is calcined in kilns, made like common lime-kilns: these are filled up to the top with coal and ore, one layer upon another, alternately, and then setting fire to the bottom layer of coal it burns till the coal is wasted away. By these means the ore becomes brittle, but the metal is not fused.

It is now taken to the furnace to be melted or, as it is usually termed, to be *smelted*; that is, to extract the metal from the dross.

The furnace, such as is represented in the plate (Fig. 1) is built of brick, and is about 24 ft. square on the outside, and near 30 ft. in height within, the middle, or widest part of which is not above 8 or 10 ft., the top and bottom being brought into a narrow compass, something like the shape of an egg. Behind the furnace are fixed two pairs of bellows, which are worked by means of a water-wheel, and they are contrived so as to play alternately, the one giving its blasts whilst the other is rising. But in many founderies the bellows used are constructed after Mr. Wilkinson's plan, by which a regular and uniform blast is continually produced. Holes are left in the furnace, which may be opened at any time to take away the scoriæ, or dross, or to permit the metal to flow out.

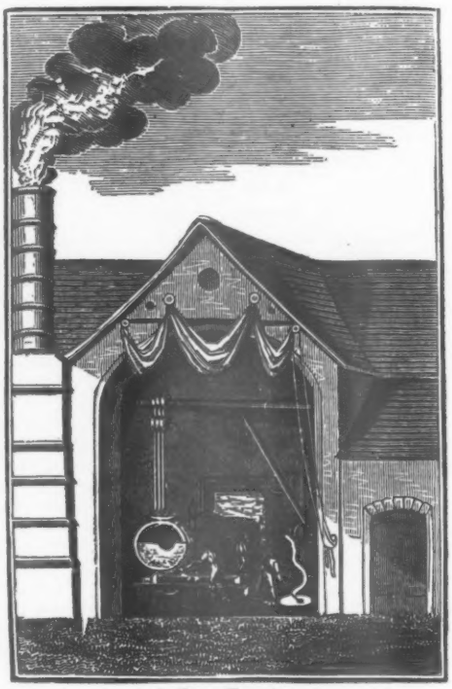
The furnace is filled with ore and charcoal, or coke; when coke is used, limestone is added to promote more effectually the reduction of the metal, by supplying carbonic acid for that purpose. The ore gradually subsides into the hottest part of the furnace, where it is melted, and the metallic parts, being the heaviest, fall to the bottom, where there is a passage made for taking off the scum. As soon as there is a sufficient quantity of metal in a complete and strong state of fusion, it is let out by a tap-hole into furrows, made in an immense bed of sand, which is prepared before the mouth of the furnace; the large mass which sets in the main furrow is called by the Founders a *sow*, and the lesser or side furrows are termed *pigs* of iron. The metal is generally made so hot before it is drawn off that it will not only run a great distance, but will keep boiling for some time in the sand.

For chimney-backs, hearths of ovens, the fronts of stoves and other small articles, the Founder takes the metal out of the receiver in large ladles, from which he pours it into moulds of fine sand.

But for the more intricate cases of Iron-Foundry, as casting of cylinders for steam-engines or pipes with various branches, moulds are formed of loam or clay, which are made nearly in the same manner as the moulding of plaister for busts, etc.

When the furnaces are once at work they keep them constantly employed for many months together, never suffering the fire to slacken night or day, but still supplying the wasting of the fuel and the ore by fresh materials poured in at the top.

The excessive and long-continued ignition kept in these furnaces gradually wastes the brick work till the sides, which are many feet thick, become unable to sustain the weight of the melted metal; so that it has sometimes been known to burst out suddenly in a violent and dreadfully-destructive stream. At certain intervals, therefore, the fire ought to be allowed



An Iron Foundry.

FIG. 2.

to go out, whatever may be the expense of rekindling it, in order to examine and repair the furnace.

Three tons of iron are sometimes run off in 24 hrs., with the application of the bellows, whilst the heat without these would scarcely melt a single hundred weight in the same time: indeed, we knew a well-conducted furnace at Redbrook, near Monmouth, where 2 tons of cast-iron were regularly run out into pigs every eleventh hour; the ore in this furnace was reduced entirely by charcoal and, being in small lumps, underwent no previous roasting.

Cast-iron is now employed in the formation of bridges of great extent, in roofs, and the girders, and joists in buildings, as well as the sash-frames and sashes. It has also been used with success in wheels and other machinery to our steam-engines. Birmingham and its neighbourhood is the great *entrepôt* for work of all kind in iron. The Soho of Messrs. Boulton & Watt, near that town, is of known celebrity. And the Colebrook-dale Company, in Shropshire, have long been

(*Concluded on page 72.*)

A New Type of Jar-Ramming Moulding Machine

In recent months Mr. W. J. Molineux, of Bhyll's Lane, Wolverhampton, has introduced to Britain an entirely new type of "combination" jar-ramming moulding machine, which carries an innovation capable of revolutionising both the production and the character of ramming induced. This innovation is of a simple character, and is brought about by allowing what amounts to a weight shown at "A" in Fig. 1 to rest on the loose sand of the mould during its consolidation by the jarring of the table. The imposition of this weight upon the sand produces some reciprocal action which reduces the ramming time and the likelihood of soft spots in the mould to a negligible quantity. No "flat-ramming" or "strickling" is required, and any degree of hardness is readily obtained. Moulds for castings in steel, bronze, aluminium or cast iron can therefore be produced at will. The complete ramming time varies from two to ten seconds, depending on the hardness required.

The machine is made in two types, one being the straight-draw or pin-lift type and the other of the turn-over variety. Each type of machine is made in several sizes. The smallest machine will deal with boxes from 20 in. by 30 in. down to those of the smallest useful sizes, with a draw of 125 mm., and the largest machines will handle boxes up to 4 ft. by 5 ft. with a draw of 450 mm. (about 17¾ in.), with a total weight of something over one ton.

The controls of both types of machine are simple. In the plain draw machine, by bringing forward a short lever fixed below the ramming table, ramming is effected, and by reversing it the mould is stripped. In the case of the turn-over machines one lever controls the jarring, and another lever the clamping and stripping of the mould.

The stripping action is sweet, as use is made of oil cylinders, which communicate an

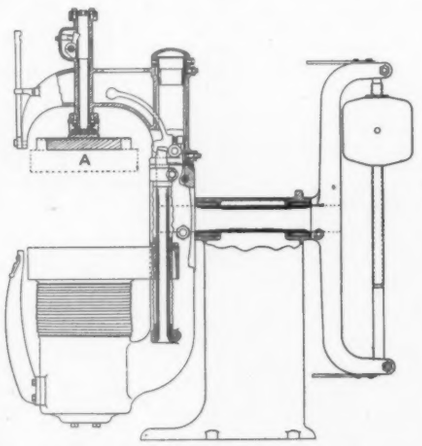


FIG. 1.—TURN-OVER JAR-RAMMING MOULDING MACHINE, INCORPORATING THE LOOSE WEIGHT DEVICE.

accelerating action. The main guides for effecting the draw are hardened and ground to ensure accuracy, and it is claimed that a pattern can be reinserted into its mould without damaging it. All wearing parts are adequately protected by leather "concertinas." The distance between the weight-plate and machine table can be varied easily by simple handwheel and screw mechanism. It is interesting to note that machines with a draw of 250 mm. do not require foundation pits. In the turn-over machine the turning is simply and easily done with little effort on the part of the operator, because the whole weight is balanced about the turning shaft centre. This shaft runs on roller bearings. The balance weight used in the turning operation is mounted on a screw so that diverse weights of moulds can be easily catered for.

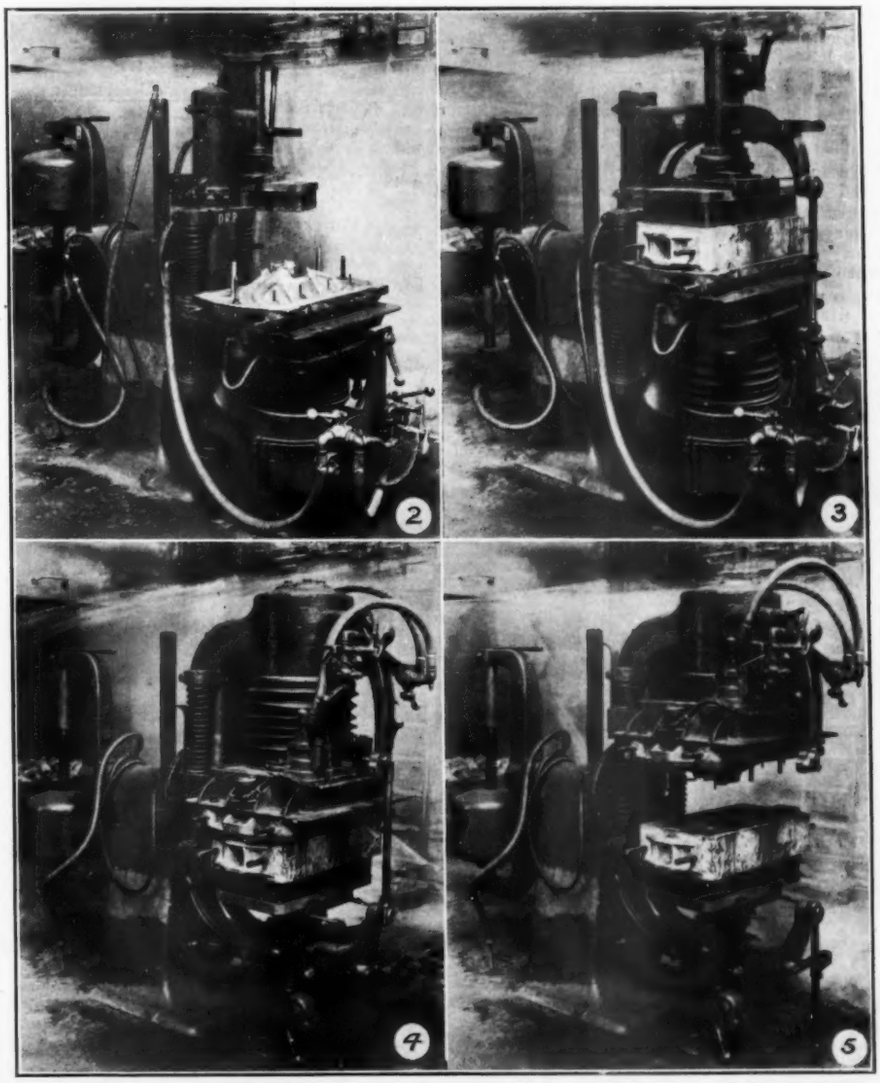
The operations of making a mould are clearly shown in Figs. 2 to 5. Fig. 2 shows the pattern mounted ready to receive the moulding box and sand, which latter can be introduced either from overhead hopper or by shovelling. Fig. 3 shows the machine at the end of the ramming operation with the weight resting on the top of the mould, the whole being clamped ready for turning over. In Fig. 4 the machine has been turned over, whilst in Fig. 5 the finished mould is ready to be removed from the machine. The machine uses compressed air at 80 to 100 lbs. per sq. in. pressure, and lubrication is by the Tecalemit method.

One interesting claim made for this new machine is that any degree of hardness of ramming can be obtained at will irrespective of the surface area of the mould. This will be better understood by comparing its action with that of the ordinary squeeze or jar-ram squeeze machine. In these machines the hardness of ramming is dependent upon the relative areas of the squeeze cylinder and the surface area of the mould being treated, whereas with this new principle of ramming there is no squeeze cylinder, but the weight plate resting on the top of the sand has a definite weight per unit area, however large the mould, so that the ramming-density must be the same irrespective of the surface area of the mould.

The writer wishes to acknowledge the courtesies extended to him by Geo. Salter & Company, Limited, of West Bromwich, and F. H. Lloyd & Company, Limited, of Wednesbury, when obtaining particulars for publication.

Catalogue Received

Insulating Materials. General Refractories, Limited, of Genefax House, Sheffield, 10, have published a well-illustrated catalogue covering the subject of insulating bricks and concrete. The materials specifically dealt with are Insulite bricks and concrete and Amberlite bricks. The object of these products is the conservation of heat in furnaces and where they are intelligently used fuel cost savings up to 20 per cent. can be registered. The catalogue shows a wealth of applications and the offer made by General Refractories to supply copies free of charge to our readers is well worth accepting.



FIGS. 2 TO 5 SHOWS THE CYCLE OF OPERATIONS INVOLVED IN MAKING A MOULD.

The Manufacture of Intricate Thin-Walled Steel Castings*

By R. HUNTER, B.Sc., Ph.D., and J. McARTHUR

While in recent years considerable progress has been made in the production, with consistency, of sound steel castings, the improvement is nowhere more marked than in those castings which may be referred to by the title of this Paper. The term "thin-walled" has, of course, to be regarded as purely relative, as naturally it is not possible to produce large castings with as thin sections as small ones. Consequently, the range covered by this Paper extends from the production of small castings weighing a few pounds, and having portions

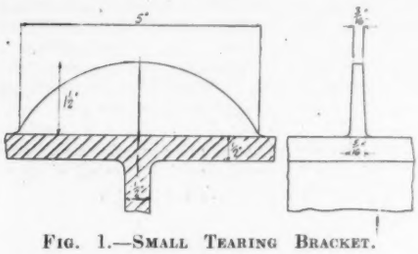


FIG. 1.—SMALL TEARING BRACKET.

only $\frac{1}{8}$ in. thick, to considerably heavier castings weighing up to approximately 38 cwts. and with a thickness of up to $\frac{1}{2}$ in.

The examples selected for detailed description are chosen as representing as wide a range of applications as possible, and at the same time serve to illustrate the many difficulties encountered and the precautions to be observed to ensure the production of sound castings. The castings chosen have all been made in sufficient quantities, in the manner described, to prove conclusively the soundness of the procedure adopted, although it is not claimed that no alternative method of manufacture is available.

In many applications for steel castings, weight is at a premium, and consequently the designer has been compelled to reduce sections to the minimum thickness to give the requisite strength, or to the minimum section acceptable by the steel founder. The latter alternative appears to be the limiting factor in many cases, as the designer can often, by using the lightest possible section in conjunction with suitable stiffening webs, provide a structure possessing the maximum strength and rigidity for a given weight.

In several of the castings described this type of design will be observed, while in others the problem is the complete covering of a very large area with thin metal, as exemplified by the combined oil engine bedplate and end casing described.

While many of the difficulties experienced in the production of thin-walled castings are naturally common to other designs, some of these troubles become intensified owing to the geometry of the thin-walled type. It is therefore proposed to deal with these aspects, with particular reference to thin-walled castings, under a number of headings.

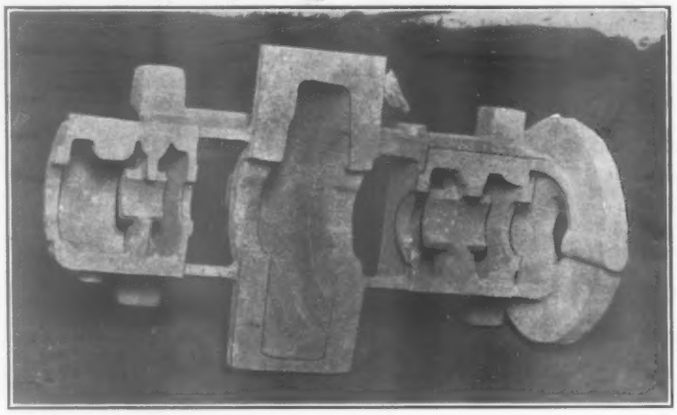


FIG. 2.—HORIZONTAL PUMP FRAMING.

Maintenance of Size

It is not surprising that the accuracy of dimensions frequently causes trouble with this type of casting. In castings of normal proportions it is sometimes possible, if difficulty be anticipated in maintaining size, to add an extra machining allowance to compensate for any minor irregularities. This procedure is seldom possible with the castings described in this Paper, as it is essential that, besides leaving an adequate machining allowance, the distance between the centre lines of the various journal pads, etc., must be accurately maintained, in order to ensure uniform loading conditions in service.

Whilst a contraction allowance of about $\frac{3}{16}$ in. per ft. is generally found to be satisfactory for steel castings of normal design, thin-walled castings, on the other hand, have as a rule to be made with a smaller allowance than this. The allowance used in some of the castings described is down to $\frac{3}{32}$ in. per ft. in the horizontal direction. The actual value employed depends on the design of the casting and sometimes, in fact, may vary in different parts of the same casting. These remarks apply to the contraction in the horizontal direction, but it is found that the normal allowance of $\frac{3}{16}$ in. per ft. in the vertical direction gives satisfactory results in practically all cases.

While it is essential to use the correct contraction allowance for each design of casting, sometimes trouble is experienced owing to different castings from the same pattern being found not to have contracted by the same amount. The possible causes of this difference in behaviour in such cases are many, but the principal variables may be regarded as: Resistance to crushing of mould and cores; temperatures of metal and mould; rate of pouring; composition of steel, etc. At present, in spite of improved technique, it cannot be claimed that absolute uniformity of all these factors can be rigidly maintained. Every effort is made to do so, but it is found that additional precautions have to be taken.

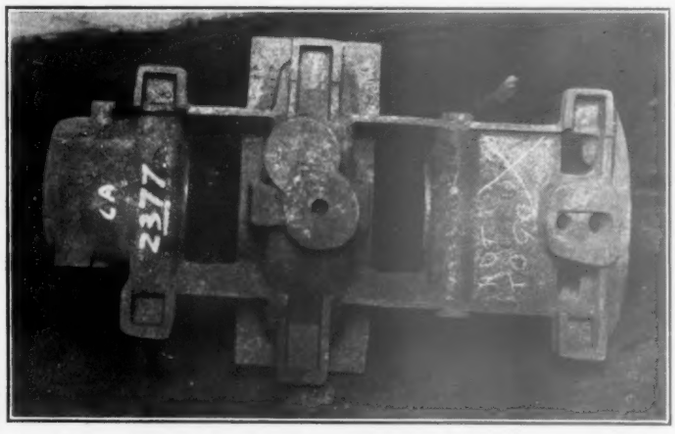


FIG. 3.—HORIZONTAL TURBINE-PUMP FRAME.

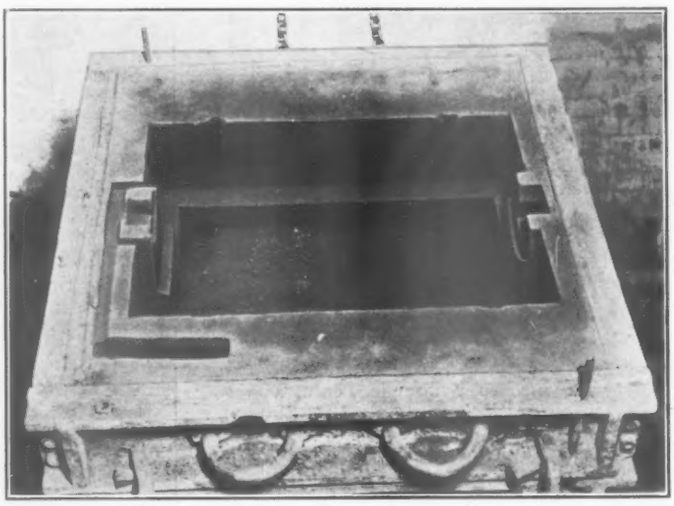


FIG. 4.—DRAG HALF MOULD FOR TURBINE-PUMP CASING.

* Paper read at the Annual Conference of the Institute of British Foundrymen in Glasgow last month.

With thin-walled castings provision is always made to shatter readily the main cores and any parts of the mould which tend to impede the free contraction of the casting. This is done at a certain standardised time, determined by experience, after completion of pouring. The actual time depends on the design of the casting; the heavier the casting the greater the lapse of time. This procedure is, of course, also adopted to minimise the possibility of hot tears, and while it may also be useful for this purpose if it is done in time, the authors find it to be always of very great assistance in ensuring uniformity of contraction.

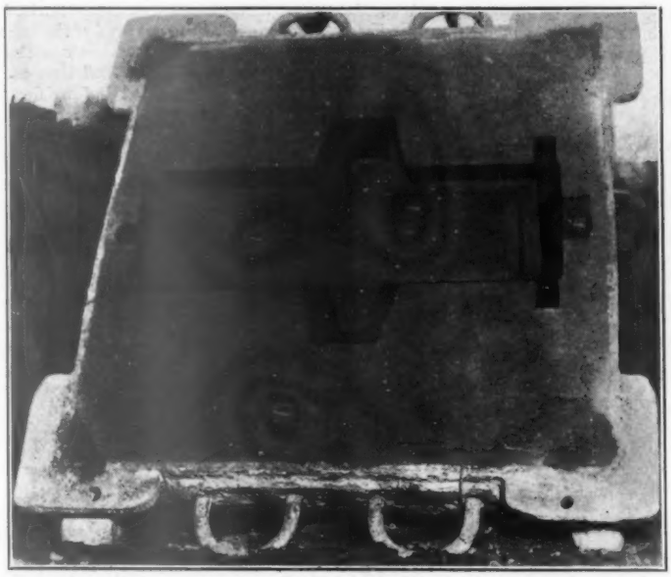


FIG. 5.—COPE OF MOULD FOR TURBINE-PUMP FRAMING.

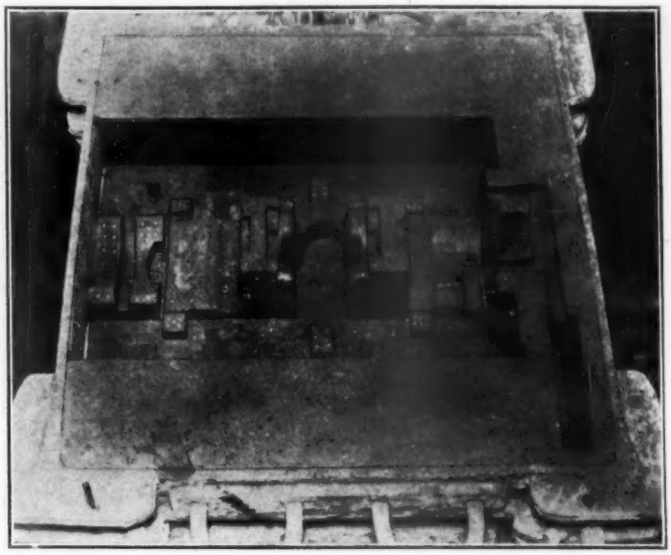


FIG. 6.—MAIN CORE IN POSITION IN HALF MOULD SHOWN IN FIG. 4.

Prevention of Hot Tears

This problem might well constitute the subject of a Paper by itself, and the authors can only afford here to touch briefly on this subject and indicate the various means adopted to prevent the occurrence of hot tears in the particular type of castings described. Hot tears are liable to occur in steel castings due to their relatively high contraction on cooling. If this contraction be unduly impeded by the mould or cores then rupture occurs, owing to the low tensile strength of the steel at elevated temperatures. While the composition of the steel and the process of steel-making influence the amount of contraction, these factors at present cannot be controlled to eliminate the danger of hot tears.

The light sections in a casting, everything else being equal, naturally cool more quickly than the heavy ones, and consequently during the cooling process are generally stronger than the latter, despite their smaller cross-sectional area. The result of this is that hot tears tend to occur at what are generally termed "hot spots" in the casting. In thin-walled castings, where the metal is maintained as uniform in thickness as is possible, these "hot spots" are generally situated at the junction of the various webs with the main body. If the cooling conditions are so regulated that the casting is cooled uniformly, then the weakness caused by "hot spots" would be absent, and the hot-tearing tendency greatly decreased. The use of suitable external chills to hasten the cooling at the desired points may achieve this ideal condition. It is not possible, however, to enunciate any definite rules to govern the weight of chill to be employed, but there are, nevertheless, certain precautions to be observed in their use.

The edges of chills should never be left square, but should be rounded with a generous radius. If this precaution be not adopted, trouble may be experienced due to surface cracks appearing on the casting at the edge of the chill. It is also important that the chill be carefully cleaned before use, and it is also found advantageous to coat it with aluminium paint prior to drying the mould.

With thin-walled castings, however, chills should be used with discrimination, since, naturally, they must add to the difficulty of running a casting whose thickness probably has been controlled by this factor. If chills appear to offer the best means of overcoming the tearing tendency, then their use is justified, but they should be made as light as possible. It is also advisable that light chills be securely tied back to the mould to prevent their possible distortion by the metal. For thin-walled castings, the authors prefer whenever possible to use suitable flat-headed nails as a mild chilling influence to assist in making the cooling conditions as uniform as possible.

Rather than add difficulties to the running of the castings by the use of chills, the strength at the hot spots can often be adequately increased by the judicious placing of brackets. The type of bracket found to be suitable for thin-walled castings is as indicated in Fig. 1.

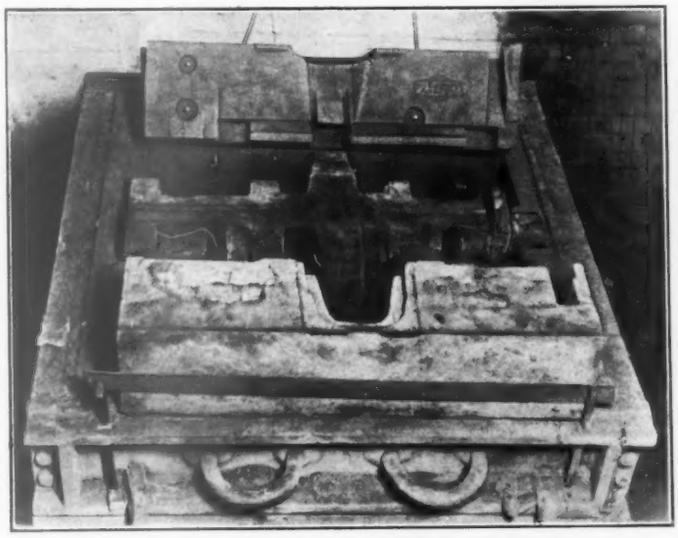


FIG. 7.—TWO CORES FORMING SIDES OF CASTING ARE SHOWN REMOVED FROM MOULD.

FIG. 8.—MAIN CENTRAL CORE FOR TURBINE-PUMP FRAMING.

D

No definite rule can be given for the number of brackets necessary, as the requirements depend so much on the design of the casting. One decided advantage of brackets is that they assist the running of the casting, particularly where the design is such that the metal rises slowly in the mould. For this reason also they are sometimes made to extend the whole length of the casting.

As will be appreciated, these precautions are necessary, because it is not practicable to make the mould and cores with a negligible degree of resistance to the contracting casting. It is naturally better practice to reduce this resistance to a minimum, rather than use devices in an attempt to overcome the deficiencies. In the description of the manufacture of the various castings, details are given of the different methods found to be of service in this direction. Probably in no other phase of steel foundry practice has greater ingenuity been exercised than in the provisions made to reduce the crushing resistance of moulds and cores. In this Paper, however, no claim is made to summarise all the expediences adopted, but the castings selected for description illustrate various assemblies which have been found to be satisfactory for the different types.

In regard to cores, the underlying principle is, of course, to make them as light as possible, consistent with adequate strength and rigidity, to resist the action of the molten metal. The details as to how this may be accomplished are given later in the Paper.

It will be observed that a cast-iron grid is generally employed to support the core and carry the additional reinforcements. This grid, wherever possible, should be situated in the mould outside the actual casting, and is, in fact, generally located in the core print. Consequently, the most rigid part of the core does not interfere with the free contraction of the casting.

Gating of the Casting

It is not possible to lay down rigid rules governing the gating of thin-walled steel castings, as each design must be considered on its merits; a common down runner is generally made to serve a number of gates, as will be observed later in the Paper. Bottom running is usually employed, but additional gates are generally added at progressively higher levels to assist the running of thin sections. Whenever the symmetry of the castings permits they are run equally from both sides. In comparison with castings of normal proportions, thin-walled castings have generally a larger number of gates and are practically never top run.

Choice of Moulding Method

The considerations affecting the choice of the moulding position of the castings under consideration are essentially similar to those arising with other types. Whenever possible, it is preferable for the principal machining faces to be cast downward. So many other factors, however, affect this choice that often it is not practicable to make the casting in this manner.

Making the casting, for example, with the principal machining faces downwards may present difficulties in moulding or in the subsequent assembly of mould and cores. On the other hand, it may be quite impossible to ensure the successful running of the casting. Frequently, however, the chief problem is the feeding of these important areas, as naturally since they are at the foot of the mould, the design of the casting may interfere with the placing of suitable feeding heads. With thin-walled castings also, the maintenance of uniform thickness is of great importance and consequently the mould and cores must be so assembled and held so that they will not be distorted by the molten metal. It will be appreciated, therefore, that generally the final decision as to the direction of moulding will be a compromise of the above factors, and that each casting must be carefully studied before deciding the most suitable method of manufacture.

Steel Requirements

The steel used for the castings described in this Paper is made in a basic-lined electric arc furnace of 5 tons capacity. The normal steel-making practice is followed, using two slags ensuring that the metal is particularly free from non-metallic inclusions and is thoroughly deoxidised. With thin-walled castings, naturally, the casting temperature must be carefully controlled, because it must be sufficiently high to ensure the complete running of the casting with no "cold shuts," and yet it must not be so high as to cause other equally serious troubles. It is possible with the electric furnace to obtain a very strict control of the analysis of the steel. The composition of the steel used is, however, quite normal and contains 0.20 to 0.25 per cent. carbon.

All castings are thoroughly annealed, and the following is a typical test in this condition:—

Test No.	462A.
Yield point	18 tons per sq. in.
Maximum stress ...	33 tons per sq. in.
Elongation	28 per cent.
Bend (1 in. by ¾ in.)	180 deg. N.F.

FIG. 9.—SHOWING POSITION AND SIZE OF THE VARIOUS FEEDING HEADS.

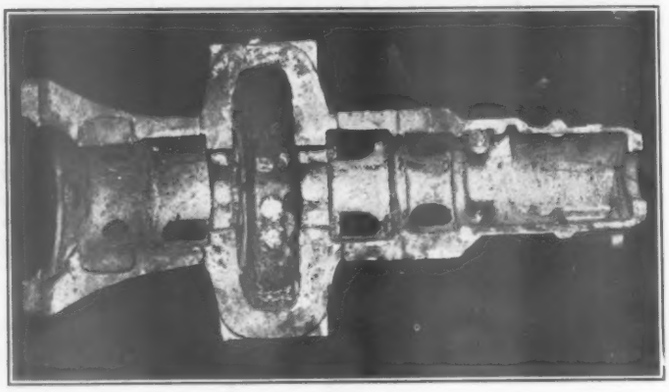


FIG. 11.—INTERIOR ASPECT OF THE CASTING SHOWN IN FIG. 10.

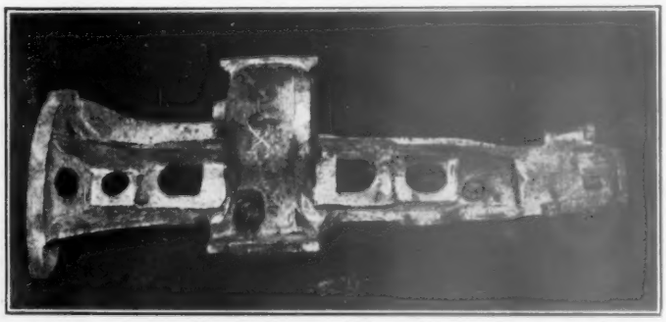


FIG. 10.—VERTICAL TURBINE-PUMP FRAMING.

FIG. 12.—COPE HALF MOULD FOR VERTICAL PUMP FRAMING.

Moulding and Core Sand

Owing to the lightness of the metal, the conditions are not as severe in some respects as encountered with heavy castings. Nevertheless, strict control of the sand is just as important as in the other branches of the industry, and care taken in sand preparation is amply recompensed by the improved surface of the castings. Dry-sand moulding is used throughout the manufacture of the castings described. A naturally-bonded silica sand is used as a facing for the cores.

The facing sand for the moulds consists of a milled mixture of the above natural sand and floor sand. The proportions in which these are mixed depends, of course, on the nature of the casting to be produced. To strengthen the surfaces of the mould and cores where required, these areas are liberally reinforced with sprigs. The oil-sand cores are made with a mixture of sharp silica sand and a proprietory bonding compound.

Horizontal Turbine Pump Framing

Figs. 2 and 3 show two views of this casting. It will be observed that the designer has made every effort to lighten the casting while still maintaining its full strength and rigidity. The general thickness of the casting is $\frac{3}{8}$ in. The journal pads are slightly heavier than this, and a fairly substantial flange forms one end of the casting.

The most important machined faces are shown in Fig. 2, comprising the bearing supports and the flange of the impeller trough. It might be considered good practice, therefore, to cast this face downwards. Experience, however, proved that it was not possible to feed adequately the journal pads and the supporting webs when this procedure was adopted. As these areas must of necessity be perfectly sound, the casting was made with the journal faces upward, in order that suitable risers could be conveniently placed. The design of the casting does not permit feeding of the flanges seen in Fig. 3 on the underside of the casting, which have consequently to be chilled to ensure soundness. A block pattern is used in the production of this framing, the mould being formed almost entirely of cores.

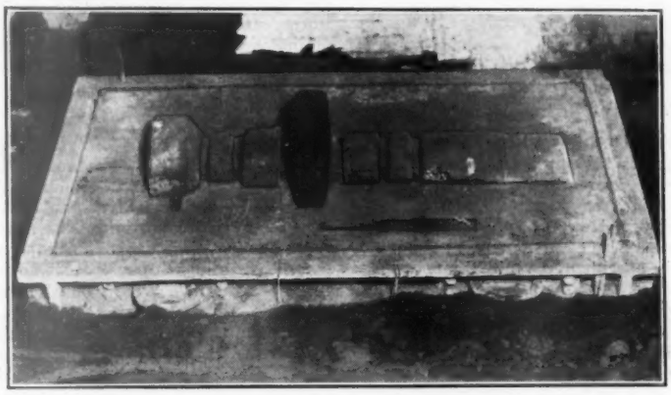


FIG. 13.—CORE ASSEMBLY ON DRAG.

Figs. 4 and 5 illustrate the drag and cope respectively, after removal of the pattern. The former also shows the location of the test-bar and the method of gating. A single down-runner leads to two gates running into the top of the sides of the casting. Each of these gates at its junction with the casting is $1\frac{1}{2}$ in. deep by $\frac{3}{8}$ in. broad.

The main bottom core is shown in position in the drag in Fig. 6. This core is reinforced with a cast-iron grid located in the core print. The facing and backing sand does not exceed $1\frac{1}{2}$ in. in thickness, and the centre of the core is composed of riddled ashes. Vents from the underside of this core are registered with suitably placed holes in the drag. The green core is placed in the drag and dried along with it.

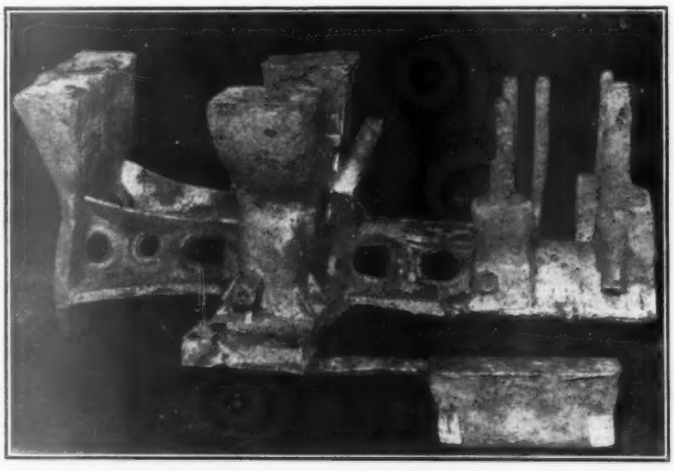


FIG. 14.—FEEDING-HEAD ARRANGEMENTS FOR A VERTICAL PUMP FRAMING.

The two cores forming the sides of the casting are shown removed from the mould in Fig. 7. These are constructed similarly to the main bottom core, except that naturally only the side forming the mould is finished with facing sand. The chills for the bosses on the sides of the casting are also shown, the bars being subsequently removed by machining.

The main central core is made in halves, as shown in Fig. 8. Whilst this core is also strengthened by means of a cast core-iron, it is too weak in the green state to withstand handling. It is, therefore, partially dried and the two halves then tied together with steel wire passed round their respective core-irons at three points.

The composite core is then dried as a unit, and is seen in its position in the mould in Fig. 7. This core is made entirely of facing sand. For venting purposes numerous pricked holes are made from the vertical joining faces of the two halves to within about $\frac{1}{4}$ in. of the surface of the core. These holes are connected to a series of grooves cut in the vertical joint, and exits for the gases are provided through three vent holes passing up through the cope as shown in Fig. 5.

The various small cores constituting the numerous oil ducts and drainage passages are made in oil-sand for convenience in fettling. Fig. 9 shows, better than any written explanation could describe, the location and size of various feeding heads.

Vertical Turbine Pump Framing

Figs. 10 and 11 show views of this framing. This type is supplied in castings up to about 5 ft. 6 in. long overall. The thickness of the metal in the body is only $\frac{1}{4}$ in., and the principal difficulties associated with this casting are the running of such light metal over this length, and the prevention of hot tears.

No great difficulties are presented in the moulding of this casting. Fig. 12 shows the cope, in which will be noted the numerous brackets which have been added to prevent tearing. The drag is made perfectly plain, containing only the prints for the main cores. The main core assembly is shown in position on the drag in Fig. 13. For convenience in handling, this core is made in three distinct parts: first, the main central core; secondly, the saddle core for the trough, and thirdly, the large diameter core shown at the left-hand side. These cores are composed entirely of facing sand reinforced with a cast-iron grid which is situated in the core print. Venting is carried out by means of pricked holes, as previously described. The cores are assembled on the drag in the green state and dried along with the mould.

The method of gating this casting is clearly seen in Fig. 12, from which it will be observed that the down-runner is situated close to the middle of the length of the casting, and that two gates run from this into the two adjacent flanges of the trough. This casting, complete with the various feeding heads, is shown in Fig. 14.

(To be continued.)

Iron and Steel Production

The British Iron and Steel Federation reports that there were 112 furnaces in blast at the end of June, three having been blown in and three put out of operation during the month. The production of pig-iron in June amounted to 644,100 tons, compared with 661,000 tons in May and 529,300 tons in June 1935; the month's production includes 154,200 tons of hematite, 354,500 tons of basic, 109,800 tons of foundry and 10,500 tons of forge pig-iron. The production of steel ingots and castings in June amounted to 965,900 tons, compared with 963,000 tons in May, 1936, and 770,000 tons in June, 1935.

NEWTON BROS. (DERBY), LIMITED, manufacturing electrical engineers and ironfounders, propose to reduce their capital from £450,000 to £39,496 4s., by cancelling 17s. on each of the 249,975 preference shares and 3s. 11 13-25d. on each of the 999,975 ordinary shares. The capital will subsequently be increased to £450,000 by the creation of 4,105,038 additional 2s. ordinary shares.

A Study of the Influence of Manganese and Molybdenum Additions to Cast Iron

By J. E. HURST

(*Concluded from page 42.*)

ANNEALED SPECIMENS

Hardness

An examination of the properties of these specimens was undertaken after subjection to an annealing treatment in which the specimens were exposed to a temperature of 950 to 975 deg. C. in a gas-fired muffle furnace for a period of two hours, followed by slow cooling in the furnace. The hardness values at the edge and centre of the annealed specimen determined with the standard 3,000 kg./10-mm. ball are given in Table IV, and the determination on the test rings with the Firth diamond hardness machine 30 kg. load representing the hardness of the specimens at a radius of 2 in. from the centre are included also.

The results at the outside edge and the centre of the specimen are in good agreement, showing that the annealing treatment has removed almost completely the irregularity in the hardness at the outside edge which existed in the "as-cast" specimens, and the uniformity in the hardness of the higher members of each series persists after this treatment. In the low manganese

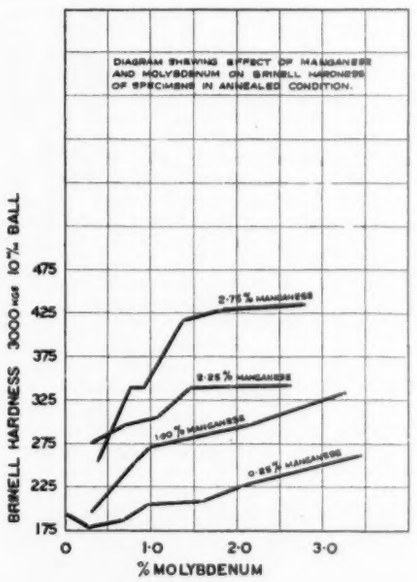


FIG. 15.

Series (No. 1) the increment in hardness with increase in molybdenum content persists after annealing, although the level of hardness is reduced to well within the limits of machinability. With each increment in manganese Series 2, 3 and 4, the tendency of the higher molybdenum content specimens to retain a higher hardness value after annealing is evident. The results are illustrated diagrammatically in Fig. 15, which clearly shows that higher hardness values are retained with molybdenum in excess of approximately 0.75 per cent. and that increment in the manganese also results in the maintenance of substantially higher hardness values. With 0.75 per cent. molybdenum manganese of 2.25 per cent. and over, the Brinell hardness is maintained at values of well over 300 and in the higher members of the series values of well over 400 are maintained.

Mechanical Properties

The mechanical test results recorded were all obtained on ring-form test pieces machined from the annealed specimens, and the results are recorded in Table IV.

Tensile Strength (Ring Test)

From the results tabulated in Table IV, it is clear that, with increase in molybdenum in Series 1, there is a substantial increase in the ultimate breaking strength, which appears to begin quite abruptly at a percentage of 0.69 per cent. Mo in specimen 1C. With an increase in manganese in the subsequent series, the general high level of strength is maintained, and the increase due to the manganese appears to be only very slight. There is no decrease with increase in manganese content. In each series, an increment in molybdenum is accompanied by an increase in the ultimate breaking strength of quite a substantial order. An increase of fully 50 per cent. in strength accompanies an increase of from 0.32 to 3.27 per cent. molybdenum in Series 2, and in the two remaining series the maximum increment in molybdenum is accompanied by an increase of about 16 per cent. in ultimate breaking-strength value.

TABLE IV.—*Mechanical Properties. Annealed Condition.*

Spec. No.	Brinell hardness. 1.	2.	3.	EN value lbs. per sq. in. × 10^6	Tensile, tons per sq. in.	Perm. set. Per cent.	Internal stress, inches.	Resilience value.	Limit of proportionality, tons per sq. in.
1A	192	192	150	19.81	17.66	52.20	0.014	37.5	—
1B	196	179	149	18.12	17.53	55.07	0.016	33.0	—
1C	196	187	186	20.70	22.25	26.60	0.030	48.4	12
1D	202	174	206	23.89	21.68	27.00	Nil	46.7	12
1E	217	228	209	21.16	22.60	14.60	0.002	49.5	14
1F	217	228	—	—	—	—	—	—	—
1G	269	262	261	20.29	23.27	8.40	0.002	41.5	12
2B	196	196	193	20.64	21.27	28.8	0.012	29.1	14
2C	—	—	255	23.36	26.87	21.8	0.012	33.6	20
2D	286	283	273	20.35	26.99	13.1	0.002	43.7	19
2E	—	241	273	—	—	—	—	—	—
2F	302	302	298	23.57	27.48	8.60	0.002	44.6	17
2G	340	340	335	23.21	33.32	4.70	0.004	—	21
3B	187	269	278	—	24·30	18.50	0.010	20.2	15
3C	302	321	298	25.00	25.24	12.80	—	32.6	23
3D	269	302	305	—	22.97	13.1	0.004	32.5	20
3E	302	340	371	26.22	24.32	9.3	0.004	33.3	21
3F	340	340	435	25.14	26.74	7.01	—	—	21
3G	340	340	448	23.96	28.45	4.60	0.003	36.0	23
4A	241	255	278	25.26	24.05	8.90	0.101	38.3	19
4B	340	340	—	—	—	—	—	—	—
4C	418	340	360	23.66	23.62	1.87	0.004	39.5	21
4D	364	340	—	—	—	—	—	—	—
4E	418	418	344	22.56	22.98	18.60	0.002	32.4	20
4F	418	430	—	—	—	—	—	—	—
4G	430	430	—	—	—	—	—	—	—

(1) Edge of annealed test pieces, 3,000-Kg. load 10-mm. ball. (2) Centre of annealed test pieces, 3,000-Kg. load 10-mm. ball. (3) Test ring, Firth 1-mm. ball, 30-Kg. load.

Modulus of Elasticity (EN Value)

In each of the series there appears to be a tendency for increase in molybdenum to be accompanied by an increase in this value. Values of 20 × 10^6 lbs. per sq. in. and over in Series 1 accompanying Brinell hardnesses of an easily-machinable order are somewhat unusual, and this would appear to be a distinctly useful attribute of molybdenum additions.

Permanent Set Values

The very high permanent set values for the samples in Series 1 are not unexpected for the annealed condition. Increase in manganese and increase in molybdenum in all cases is accompanied by a marked decrease in permanent set. This may prove to be an important attribute of joint manganese and molybdenum additions, in that they exert apparently a pronounced effect in maintaining the resistance to plastic deformation even after subjection to a fairly drastic annealing treatment and without any loss in ultimate breaking strength or even lowering of the modulus of elasticity (EN value). In other words, the elastic deformation properties are maintained and the plastic deformation qualities are reduced very substantially, particularly with the higher manganese-molybdenum values.

Internal Stress

As in the case of previous investigations, utilising this method, the author has described as internal stress the amount of movement observed between the free-gap and the gap cut in a restrained condition. The numerical values given which represent the gap movement in inches are all positive, that is to say, that the gap opened or increased on slitting. It is remarkable to find that, even after the fairly drastic annealing treatment to which the specimens have been subjected, there exists a substantial internal stress, as indicated by the gap opening in some of the specimens. It is also quite noticeable and of great interest to observe, particularly in Series 2, that increase in molybdenum content is accompanied by a decrease in the amount of internal stress (gap opening). There is evidence of the same influence on the other series. There does not appear to be any evidence that this is affected in any way by the increase in manganese content.

Stress/Deflection Curves

The stress/deflection curves illustrating the change in character of these for the specimens Series 1, are illustrated in Fig. 16. With the manganese constant at the low value of 0.25 per cent. approximately, and with molybdenum steadily increasing up to approximately 3.5 per cent., the character of the curves undergoes changes which are typified by the curves 1A, 1C, 1E and 1G. They show clearly the change and increase in modulus of elasticity and the increase in ultimate breaking strength. The pronounced

curvature in the specimens free from molybdenum, the effect of plastic deformation, is altered in character somewhat with increasing percentages of molybdenum.

In the molybdenum-free and low-molybdenum specimens, the limit of the straight portion of the curve is approximately 6 tons per sq. in. (def. 0.45 in.), and if this be regarded as a limit of proportionality, it will be seen that, with increasing molybdenum, this is raised very

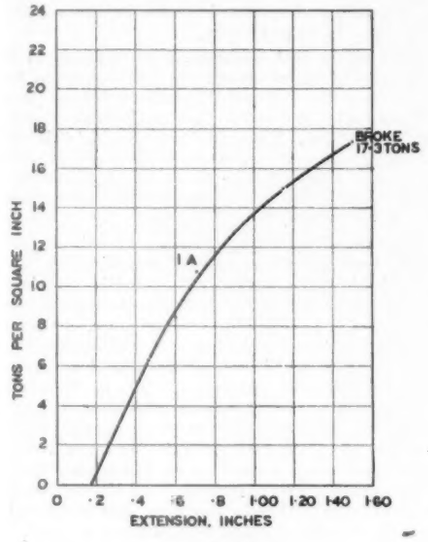


FIG. 16 (*a*).

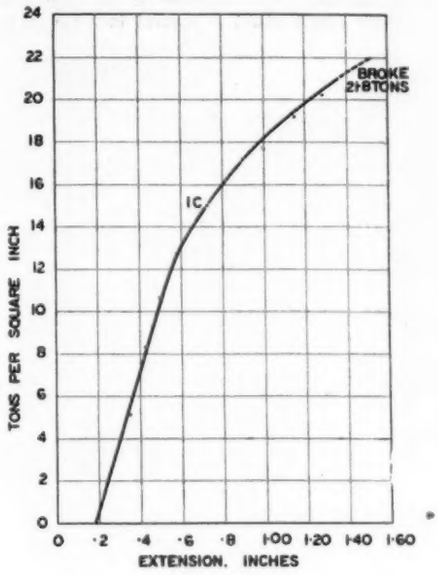


FIG. 16 (*b*).

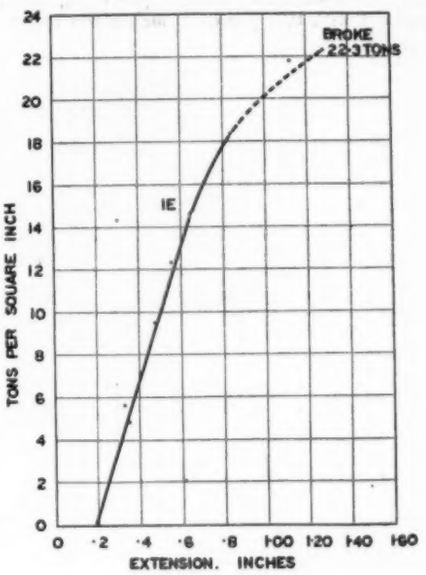


FIG. 16 (*c*).

substantially to approximately 12 tons per sq. in. in Specimen 1C, containing 0.69 per cent. molybdenum and slightly higher than 14 tons per sq. in. in the remaining specimens. The total deflection at breaking is very little affected with increase in molybdenum. The included area of the curves, *i.e.*, the resilience value, shows a very pronounced increase in specimen 1C, containing 0.69 per cent. molybdenum. This increase amounts to about 33⅓ per cent., and is

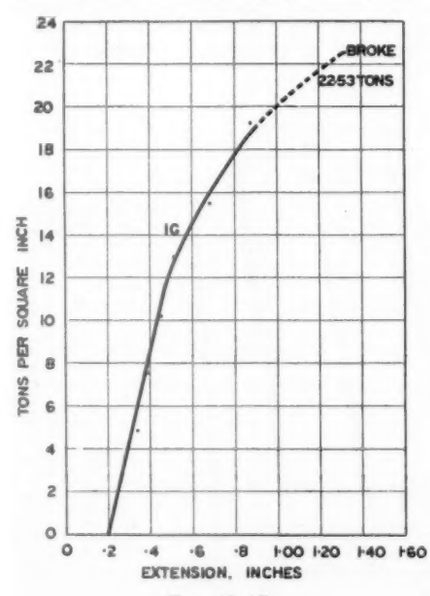


FIG. 16 (*d*).

apparently not increased very much by increase in percentage of molybdenum above this value.

In the annealed condition the presence of 0.69 per cent. molybdenum therefore brings about an increase in toughness of approximately 33⅓ per cent., which is maintained, but not substantially increased, by further quantities of molyb-

denum. In addition, the alloys become more truly elastic over a wider stress range (at least 100 per cent. greater than the low molybdenum specimens), and the total deflection or strain at fracture remains practically unaltered.

The effect of increasing manganese content with increase in molybdenum is shown by the stress/deflection curves for Series 2, 3 and 4. The curves 2D, 3D, 3F and 4C illustrated in Fig. 17 are characteristic. The same influence of molybdenum is apparent in each case and the influence of increasing quantities of manganese appears to show a tendency towards increasing the limit of proportionality to a still slightly higher figure in the neighbourhood of 18 tons per sq. in., and even with the higher hardness values the toughness as represented by the resilience values remains practically unimpaired. It is again noticeable that a percentage of approximately 0.70 per cent. molybdenum in each of these series appears to be necessary to develop the marked change in properties due to this element.

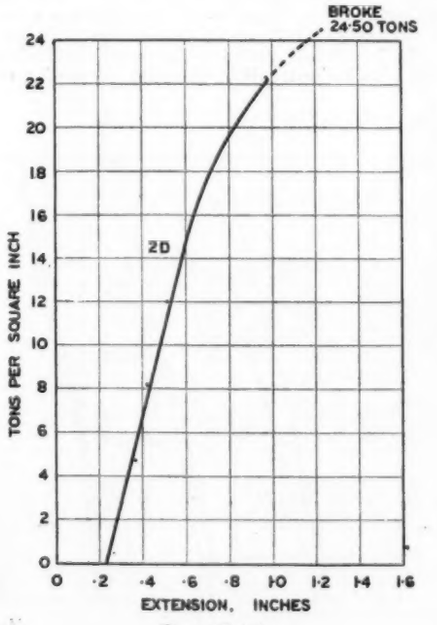


FIG. 17 (*a*).

Elastic Hysteresis Loops

Test rings were submitted to a complete cycle of stress and the character of the elastic hysteresis loops determined. The method* adopted has been described previously by the author, but is again briefly described as follows:—Starting with closing the test rings, stress was applied gradually and the reduction in gap opening measured with increasing stress. The stress range adopted was 12 tons per sq. in. calculated on the basis of the relationship given in B.S.I. Specification 5004 and when the stress was attained the load was gradually removed, and the gap dimensions measured with the gradual decrement of stress. The same specimen was then subject to a stress (tensile stress) applied to open the gap following the same procedure in the measurement of the strain. The curves plotted showing the relation between gap opening and the cycle of applied stress yield characteristic hysteresis loops as shown in the diagrams. A complete set of diagrams for the Series 3A to 3G is illustrated in Fig. 18, in that they are typical of the change in character

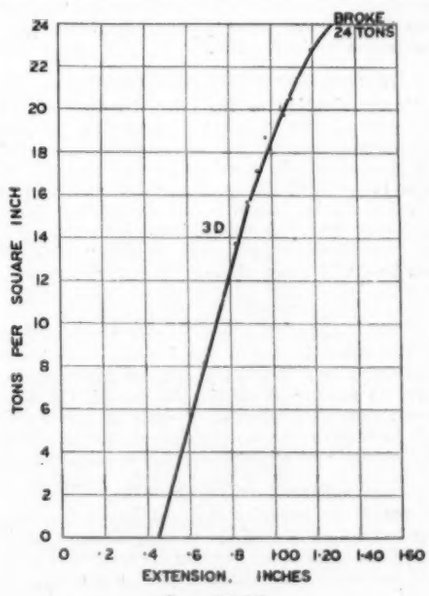


FIG. 17 (*b*).

* FOUNDRY TRADE JOURNAL, December 27, 1934, p. 405.

of the diagrams with increasing molybdenum content in each series. With increasing molybdenum content there is a marked steady decrease in the enclosed areas of the loops indicating a decrease in the hysteresis and hysteresis stress with increasing molybdenum content.

There is no striking difference in character between these hysteresis loops with increase in manganese content beyond 1 per cent., but in Series 1 with 0.25 per cent. manganese approxi-

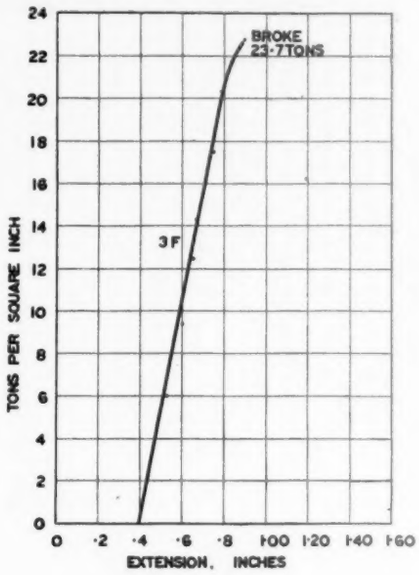


FIG. 17 (*c*).

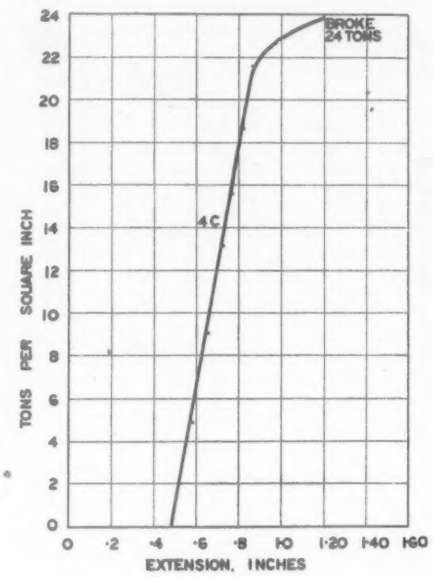


FIG. 17 (*d*).

mately, the low manganese specimens 1A to 1C show very much greater hysteresis and hysteresis stress than in other specimens. As in the case of the other properties, the marked change in character of the loops occurs with a percentage of molybdenum about 0.70 per cent. (specimen 1C) and even in Series 1 the specimens with molybdenum in excess of 0.70 per cent. (specimen 1C) yield hysteresis loops which differ very little from those yielded by the higher manganese content series.

Microstructure (Annealed Condition)

An examination of the microstructure of the specimens taken from the annealed samples shows that the structure has undergone a marked change due to this treatment. The photographs Figs. 19 to 22 of the specimens 3 F and 4C will be sufficient to illustrate the change in structural character. A comparison of these at the low magnification with those in the "as-cast" condition will show at once that there appears to have been very little change in the amount of the carbide (white) constituent present, but that the martensitic matrix has undergone a marked spheroidising or balling-up. The black constituent in 3 F which resembles troostite also exists in similar quantities in the high molybdenum content specimens of each of the series. This balling-up or spheroidising of the matrix is characteristic of all the annealed specimens.

Summary and Conclusions

From these experimental results it is clear that increasing quantities of molybdenum additions tend to produce a white fracture and with very low manganese content (0.25 per cent.) an addition of 1 per cent. of molybdenum is required to ensure a white fracture under the conditions of the experiments. With increasing amounts of manganese the amount of molybdenum necessary to ensure complete whiteness decreases, and with 2.75 per cent. of the former element present a completely white fracture is obtained with 0.39 per cent. molybdenum in the "as-cast" condition and without the aid of any chills.

In this same condition the conjoint additions of these two elements have a marked effect upon the hardness. In the presence of small amounts of manganese the effect of increasing the molybdenum content on the Brinell hardness is not very great until a percentage of approximately 0.70 per cent. of this element is attained and further increases beyond this value bring about increased hardness. Increase in the manganese contents brings about a general increase in the hardness level, for a given molybdenum content and extremely high hardness values of 600 Brinell and over are obtained with manganese and molybdenum in excess of 2.25 per cent. and 1.00 per cent. respectively.

Under all the conditions of manganese content examined molybdenum commences to show a marked effect in increasing the hardness when a percentage in the neighbourhood of 0.70 per cent. is reached and the increased hardening effect is obtained uniformly across the section of the specimens examined. This effect of the joint addition of these two elements on the hardness appears to be due to their action in promoting the formation of a martensitic constituent.

Manganese appears to be necessary to ensure the formation of this, and in the specimens containing only 0.25 per cent. manganese none was observed up to 3.45 per cent. molybdenum.

Owing to the fact that no specimens having a manganese content intermediate between 0.25 and 1.0 per cent. were examined, it has not been possible to fix the manganese content at which the martensitic structure begins to form, but by extrapolation from the observations made with higher manganese it appears probable that at least 0.5 to 0.75 per cent. of this element is necessary. With manganese in excess of this amount, increases both in manganese and molybdenum bring about an increase in the amount of martensitic constituent.

Increase in molybdenum alone appears to be accompanied by an increase in the amount of the carbide constituent and this same influence probably persists in conjunction with higher manganese contents. The combined effect of this and the production of the martensitic constituent is probably responsible for the very high hardness values of the high-manganese-molybdenum members of the series.

The annealing treatment adopted in the experiments has had the effect of "balling-up" or spheroidising the pearlitic-martensitic matrices, and in the more highly martensitic alloys a constituent of troostitic character appears. In these same alloys the carbide constituent appears to be very stable and it was difficult to observe any such reduction in quantity of this as appeared in the lower manganese-molybdenum content specimens. This observation has a bearing probably on the substantially-high hardness values maintained after annealing in the higher manganese-molybdenum specimens. All the specimens undergo a reduction in hardness due to annealing but it will be noted that with say 2.75 per cent. manganese and 1.5 per cent. molybdenum hardnesses of upwards of 400 Brinell are still maintained. This is in all probability due to the stability of the carbides in these alloys, the reduction in hardness as from the "as-cast" condition being due in the main to the spheroidising of the martensitic and the formation of some troostite constituent.

Whilst no mechanical tests were made on the materials in the "as-cast" condition, it is worthy of record that all the specimens appeared to be very tough and strong in handling. The mechanical tests in the annealed condition show that in the main increase in molybdenum is accompanied by increase in strength of quite a substantial order. Again the marked effect of this constituent appears to begin with a percentage in the neighbourhood of 0.70 per cent. Manganese in itself does not appear to be responsible for any increase in strength of a marked order nor does it bring about any reduction in strength. In fact with all the percentages of manganese examined the high strength due to

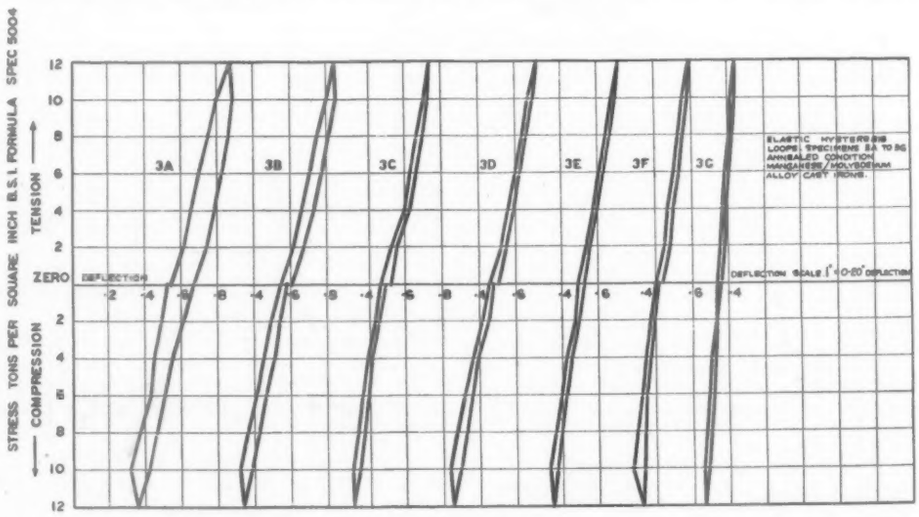
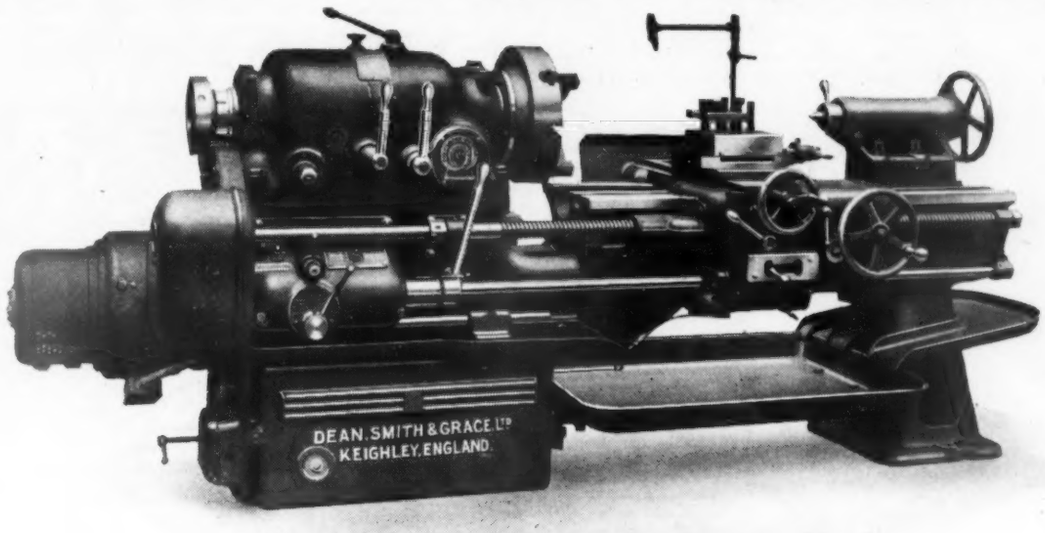


FIG. 18.

For Heavy Engineering Castings



FOR heavier types of engineering castings, such as those used in lathes, Stanton Low Phosphorus Foundry Pig Iron is particularly suitable. It can be supplied within limits of 0.25% margins of silicon.

The Super High Speed Production Lathe illustrated above is by Dean, Smith & Grace, Limited, of Keighley, who are regular users of

STANTON
LOW PHOSPHORUS FOUNDRY PIG IRON

The largest Producers of Foundry Pig Iron (for Sale) in Great Britain

Graph. Carbon %	Comb'd Carbon %	Total Carbon %	Silicon %	Sulphur %	Phos. %	Mang. %
3·35	0·35	3·7	2·5–3·5	0·03–0·05	0·73–0·78	0·9–1·0

The Stanton Ironworks Company Limited, Near Nottingham

the molybdenum contents appears to be maintained.

The stress/deflection curves and the area of these or the resilience values show that with an increase in molybdenum of 0.70 per cent. this value is substantially raised, but further increments in the two elements do not appear to be accompanied by any further increase in resilience values. They are, however, accompanied by certain other changes in what might be termed the elastic characteristics. Increase in both molybdenum and manganese appear to extend the range of close approach to proportionality and what has been termed the limit of proportionality has been distinctly raised by both these elements. The elastic deformation properties are maintained and the plastic deformation or permanent set properties are reduced. The modulus of elasticity (EN value) shows a marked tendency to increase with increasing molybdenum contents and the elastic hysteresis loops over the stress cycle adopted show a substantial diminution in area with increase in both constituents.

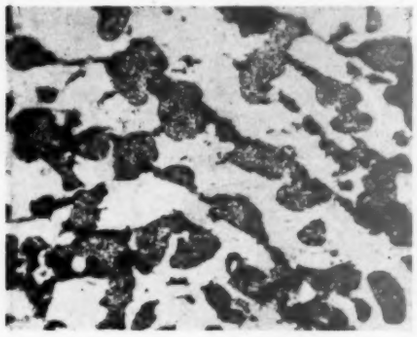


FIG. 19.—3F. ANNEALED. × 250 DIAS. ETCHED PICRIC ACID.

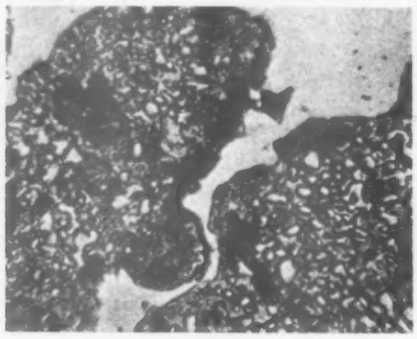


FIG. 20.—3F. ANNEALED. × 1,500 DIAS. ETCHED PICRIC ACID.

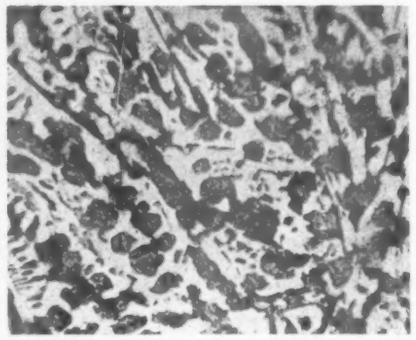


FIG. 21.—4C. ANNEALED. × 250 DIAS. ETCHED PICRIC ACID.

The apparent effect of increase in molybdenum content in reducing the magnitude of the internal stress effects after annealing is also an observation of very great interest. A general observation on the results of the mechanical test results of these specimens in the annealed condition is that the joint addition of these two elements is not accompanied by any diminution in strength characteristics, and on these grounds it would appear that these joint additions could be used with every confidence.

Joint additions of manganese and molybdenum produce cast irons having martensitic characteristics with strengths and attributes of the strength properties of a very high order.

Certain aspects of the results obtained in this investigation are clearly of importance, and it is considered legitimate to make reference in general terms to some of the potential industrial applications in which results of this nature are worthy of consideration.

Chilled and Grain Rolls

The fact that molybdenum alloy additions are used already in the manufacture of chilled and grain rolls and castings used for crushing, grinding and pulverising machinery was in a large measure responsible for the inception of this investigation. It is well known that castings coming within this category are required to withstand a wide range of duty-conditions. It appears quite likely that the properties obtainable by the joint use of manganese-molybdenum alloy additions may be of value, and certainly worthy of consideration in many aspects of the manufacture of castings of this nature where extremely high hardness values are required as, for example, in chilled rolls for certain operations alloy additions of this type may prove of interest. From this point of view, in addition to the possible high-hardness values, the investigations tend to show that these are accompanied by high-strength values, high resistance to both elastic and plastic deformation, low elastic-hysteresis and possibly high-fatigue resistance.

In this connection the properties of this type of alloy iron in the annealed condition are of interest. The effect of the joint additions in stabilising the carbide constituent and thus enabling a high hardness value to be maintained, is one point of interest. Also it must be borne in mind that the measured values of the various properties have been obtained for these samples in the annealed conditions, and these point to the possibility of obtaining high resistance to deformation and fatigue in addition to high-strength values in this condition. An additional aspect of some importance in considerations of this nature, is the apparent reduction in internal-stress value due to the manganese-molybdenum additions and also the effect of these additions in obtaining uniformity of hardness across the sections examined.

In the production of grain rolls, particularly section rolls, these results may be worthy of consideration. It should be possible, by the use of joint additions of molybdenum and manganese to obtain substantially-high degrees of hardness, still within the limits of machinability desired for castings of this class. These higher hardness values, coupled with the high-strength values as revealed by the results of this investigation, may be found to be accompanied by a greater life under the service conditions demanded of this class of roll.

Wear Resisting Castings

There are a number of other types of castings used in crushing, grinding and pulverising machinery in which similar properties are required, and where this type of alloy iron might conceivably be of service.

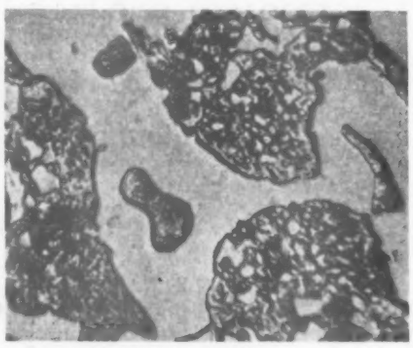


FIG. 22.—4C. ANNEALED. × 1,500 DIAS. ETCHED PICRIC ACID.

Engine Castings

The possibility of obtaining high hardness and martensitic characteristics, coupled with high strength values and high resistance to deformation by the use of manganese-molybdenum additions, may be of value in the production of castings such as cylinders, cylinder liners, valve seats, crankshafts and camshafts. Here again, the high strength values and the possible high fatigue resistance may prove to be important properties of this type of alloy.

General Castings

In the realm of general castings there are numerous examples, such as gear wheels, worm castings, castings called upon to withstand abrasive conditions, where the properties of the type revealed by this investigation may prove of interest.

The above are to be taken as purely general comments intended to focus attention on some directions in which it is possible that results of the type yielded by this investigation might prove of value, and in the hope that they may stimulate further experiment and investigation in a similar direction.

This investigation and research has been carried out in the laboratories of Bradley & Foster, Limited, in conjunction with High Speed Steel Alloys, Limited. The author desires to place on record his thanks for their co-operation and consent to the publication of the results.

Book Review

Die Betriebspraxis der Eisen, Stahl und Metallgiesserei. (Shop Practice in Iron, Steel and Non-Ferrous Foundries).—Vol. 21. Die Schablonenformerei in Sand und Lehm (Strickle Moulding in Sand and Loam), by A. Giessel. Published by Verlag Wilhelm Knapp in Halle (Saale), Germany. Price (paper backs) 8.80 Rmk.

Herr Giessel deals with the question of strickle moulding in a most comprehensive manner; starting with the various mould materials at our disposal he passes on to the means of shaping these materials into the desired shapes, and finally gives examples of many well known applications and a few original applications of this branch of the moulders' art.

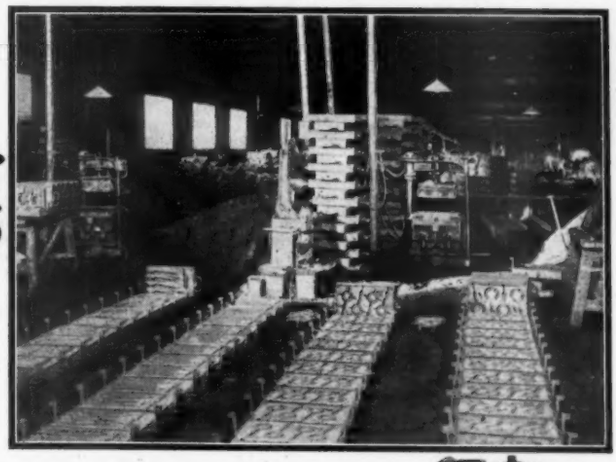
There are people who maintain that strickle moulding is old fashioned and out of date. Let them read this volume. Herr Giessel maintains that the reverse is the case, and proceeds to prove that, with proper equipment, this is true.

The book contains a wealth of knowledge and over two hundred sketches illustrating clearly the principles which Herr Giessel propounds: it should be of considerable value to any foundry already engaged in strickle moulding, and especially so to those whose experience of this class of work is limited. It is a valuable addition to the extremely scattered information available on this subject.

J. C.

B.I. MAGNETIC MOULDING MACHINES

BRITISH PATENTS 321777, 322720, 349173, 355809



Each machine forms a complete unit.

Construction and control are simple.

Operating costs are very low. Power is only used during the squeeze operation—approx. 2 seconds. Upkeep costs are very small. There are few moving parts, no glands or packings, and no troublesome pipe lines.

If only A.C. is available, a relatively small A.C./D.C. convertor is required. A sequence relay device allows of operating a battery of machines from one convertor. Electric vibrators and heaters can be supplied if required. All parts are efficiently guarded against ingress of sand. The illustration shows B.I. Magnetic Moulding Machines installed in the foundry of Messrs. Stoves Ltd., Rainhill, Lancs.

THE ONLY MOULDING MACHINES IN THE WORLD WHICH UTILISE ELECTRICITY AS THE DIRECT POWER MEDIUM FOR HIGH PRODUCTION WORK.

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The Week's News in Brief

Trade Talk

DAVID AULD & SONS, LIMITED, are to make additions to their foundry at Rowchester Street, Glasgow.

AFTER BEING IDLE for nearly five years, the Sunderland shipyard of Sir James Laing & Sons, Limited, has been reopened. The first keel is in the process of being laid.

AN ORDER has been placed with Vickers-Armstrongs, Limited, Barrow-in-Furness, by James Fisher & Sons, Limited, for a motor cargo vessel of approximately 950 tons deadweight.

IN FUTURE the Shipping, Engineering and Machinery Exhibition will be known as the Engineering and Marine Exhibition. The next Exhibition will be held at Olympia in September, 1937.

HENRY BERRY & COMPANY, LIMITED, Croydon Works, Hunslet, Leeds, announce that on and after August 10 next the address of their London office will be Shell-Mex House, Victoria Embankment, London, W.C.2.

TO COPE with increased business in the Midlands, E. H. Jones (Machine Tools), Limited, have found it necessary to enlarge their Birmingham showrooms. Additional premises have been secured adjoining the present showrooms at 50, Church Street.

ALFRED HOLT & COMPANY, owners of the Blue Funnel fleet, and the Glen Line are considering the question of building ten fast passenger motor vessels to compete with Japanese ships on the Far East routes. This programme would involve an expenditure of £2,500,000 and represents 100,000 tons of new shipping.

Ironfounding as a Career in 1824

(*Concluded from page* 60.)

famous for a variety of cast-iron materials for building both houses and bridges. The Carron Iron-works, in Scotland, are also well known: the guns known in war under the name of carronades derive their name from this last foundery; for the mode of casting which, as well as cannon generally, we refer to more voluminous writings, merely adding that cannon are always cast with a large cap at their muzzle, which was originally cut off with a saw, but now a machine is used for the purpose, which a man works by turning a lathe, and as the turning goes on the turner uses a chisel with which he cuts into the gun to about 1½ in. deep. The cap so cut is broken off by being hammered.

An appendix to "English Trades" contains an illustrated description of the Colebrookdale Foundry. It is shown in Fig. 2.

Iron Foundry

This engraving (Fig. 2) represents the interior of one of the principal iron foundries in Colebrook Dale, Shropshire. The air-hole is visible at the end, and a man is employed drawing the dross from the liquid metal, which is represented to the right running from an orifice into a basin, where a man is lading it to pour into the moulds or matrices; two other men are also visible, similarly employed, and a fourth is emptying the metal into moulds.

To keep the moulds steady, weights are commonly placed on them, but in the present case a cask of metal is suspended by a crane and let fall on the moulds, and by means of the crane shifted from mould to mould as occasion requires; such weights not only give precision to the casting, but prevent explosion from the expansion of the air and moisture within the moulds. The tarpawling in front is intended to be let down in case of wet weather, as rain to windward would spoil the moulds and explode in contact with the liquid metal. The chimney of the furnace is represented to the left, and the intensity of the fire is maintained by means of double blast-bellows, the noise of which exceeds the conception of those who never heard them.

THE SECRETARY of the United Patternmakers' Association states that there were only 272 members unemployed last month, one of the best returns for a long period. The executive of the Association recommends that a vote of the members be taken at the September meeting for and against a delegate conference to consider alterations in rules.

IN ORDER TO COMPLY with Stock Exchange regulations, particulars have been published recently of the capital and objects of Aeroplane & Motor Aluminium Castings, Limited. The company has an authorised and issued share capital of £80,000, and is acquiring, as from March 31, 1936, the business of aluminium-casting specialists formerly carried on at Erdington, Birmingham, by Heritier, Limited.

OWING TO AN OUTBREAK of fire in an adjoining building, the head office of James Keith & Blackman Company, Limited, at 27, Farringdon Avenue, London, E.C.4, has been affected. This, unfortunately, has resulted in a certain amount of delay in dealing with correspondence, as the firm's records have been damaged. They inform us, however, that this will not affect production at the works.

THE SOUTH DURHAM STEEL & IRON COMPANY, LIMITED, have placed a contract with Gibbon Bros., Limited, of Dudley, for the erection of new coke-ovens at Seaton Carew. The contract for the supply of three turbo-blowers has been placed with Richardsons, Westgarth & Company, Limited, of Hartlepool, while the Whessoe Foundry & Engineering Company, Limited, Darlington, is to supply the blast-furnace-gas plant.

AFTER BEING CLOSED for twelve years, the Eggles-cliffe Foundry has been restarted by Head, Wrightson & Company, Limited, of Thornaby-on-Tees. Sir Guy Wrightson, Bt., chairman of the company, lighted the cupola on July 13, and it is hoped to provide continuous employment for about 100 men. The foundry will be engaged in the production of heavy castings in connection with large Government and other contracts which the firm have in hand.

A RESOLUTION AUTHORISING the directors of Colvilles, Limited, to acquire the whole ordinary share capital in the Lanarkshire Steel Company, Limited, was passed at an extraordinary general meeting in Glasgow on July 17. The acquisition will be made in exchange for an allotment of 130,000 of the unissued ordinary shares of £1 each in Colvilles. Mr. John Craig, chairman and managing director, explained that the directors had not been actuated by a desire to create anything in the form of a monopoly, but to create a company which, by its structure and its potentialities, should be enabled worthily and efficiently to maintain and develop the steel industry in Scotland. Only by combining the resources of the several companies now under their control would the best results be obtained.

Company Reports

Crossley Bros., Limited.—Final dividends of 5 per cent. actual on the 5 per cent. preference shares and 5 per cent. on the 7 per cent. non-cumulative preferred ordinary shares.

Charles Churchill & Company, Limited. — Net profit, £18,017; brought in, £2,847; dividend of 6 per cent., tax free, on the preference shares for 12 months to March 31, 1932, £3,600; carried forward, £17,264.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Metalectric Furnaces, Limited.—Capital, £30,000. Manufacturers of electric furnaces, etc. Subscriber: G. C. Castle, "Pomona," Warwick Road, Solihull, Warwickshire.

New Broken Hill Consolidated, Limited, 95, Gresham Street, London, E.C.2.—Capital, £600,000. To acquire mines in New South Wales or elsewhere, and to enter into an agreement with the Zinc Corporation, Limited.

Personal

MR. W. H. MEADOWCROFT, a Past-President of the Lancashire Branch of the Institute of British Foundrymen, has been appointed manager of Core Oils, Limited, Metier Works, College Street, Rochdale.

MR. T. B. CORBETT, of John Williams & Company (Wishaw), 1922, Limited, returned home last week on the "Queen Mary" after a five weeks' visit to the United States.

MR. LAWSON SPIERS has been appointed secretary and treasurer of the staff superannuation fund of Colvilles, Limited, and auxiliary companies. Mr. James Petrie has been appointed finance secretary for Colvilles, Limited.

LORD HIRST OF WITTON, President of the Federation of British Industries, has been elected chairman of the British Committee on Empire Trade, in succession to Sir Alan Anderson, G.B.E., M.P. This committee is representative of the Associated Chambers of Commerce, the Chamber of Shipping, and the Federation of British Industries.

MR. W. R. LYSAGHT, head of John Lysaght, Limited, Orb Ironworks, Newport, Mon, is to be given the freedom of Newport. A decision to admit Mr. Lysaght as an honorary freeman was reached by Newport Town Council last week. Mr. Lysaght has been connected with the town for 40 years.

Wills

COOPER, SIR J. A., a director of Vickers-Armstrongs, Limited, and other companies	£42,507
DOWNS, CHARLES, managing director of Rose, Downs & Thompson, Limited, engineers and ironfounders, of Hull...	£49,207
SANDS, JOHN, late proprietor of the Central Foundry Company, Birmingham	£18,577

Contracts Open

Cairo, August 26.—Supply and erection of a drainage pumping station at El Rahawi, consisting of four 5½ cub. metres per sec. Diesel-driven pumps, necessary building and foundation work and auxiliary machinery, for the Director-General, Mechanical and Electrical Department, Ministry of Public Works, Cairo. The Chief Inspecting Engineer to the Egyptian Government, 41, Tothill Street, London, S.W.1. (Fee £E.5.)

Camborne, July 27.—Three vertical-spindle electrically-driven pumps, for the Camborne-Redruth Urban District Council. Mr. J. Chadwick, engineer, Bletchley, Bucks. (Fee £2 2s., returnable.)

Driffield, July 27.—Pumping machinery, for the Rural District Council. Mr. C. B. Newton, consulting engineer, Burnett Avenue, High Street, Hull. (Fee £5 5s., returnable.)

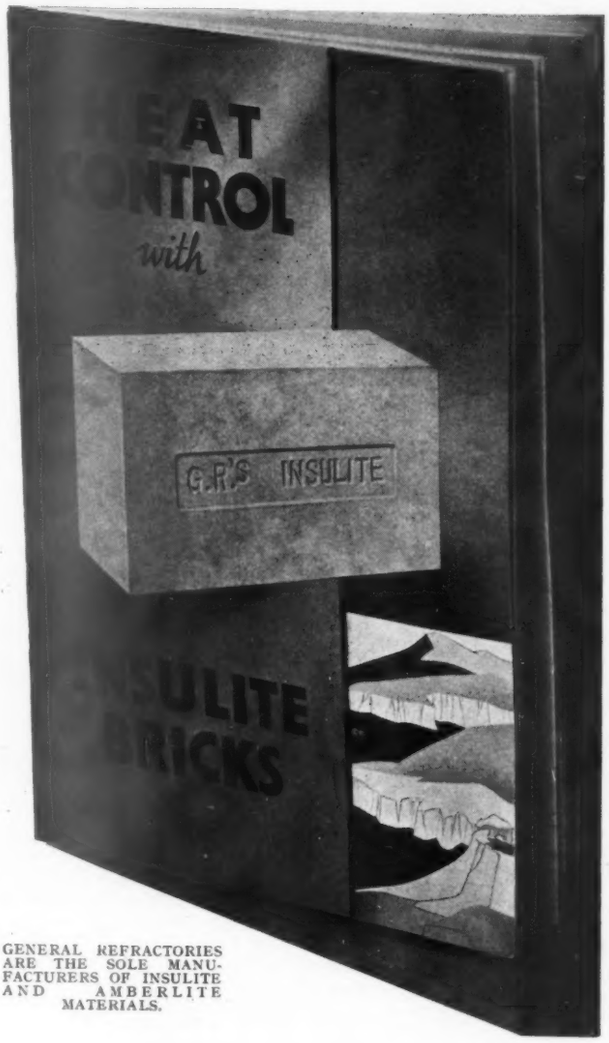
Washington, July 31.—Pumping machinery for the Chanctonbury Rural District Council. Mr. P. Avling, clerk, Council Offices, Storrington, Sussex. (Fee £3 3s., returnable.)

Company Meeting

Greenwood & Batley, Limited

At the annual meeting of Greenwood & Batley, Limited, COL. H. A. MICKLEM (chairman) said that the improvement in general conditions at home had been maintained, and the company's sales for the year under review had increased by nearly 12 per cent. The orders on hand showed a large increase over the corresponding date last year, which was distributed over most of the departments. Further substantial advances in wages had recently been granted or promised. These advances had been general throughout the engineering trade, and so far as home orders were concerned did not prejudice the company's competitive power if the goods produced were adequately protected by tariffs against foreign competition, though they might later affect the volume of work. But home trade alone was not a sufficient basis for national prosperity, for which foreign trade was also essential. During last year 27 per cent. of their sales were made abroad. Such contracts were obtained in keen rivalry with foreign manufacturers, and they could not but feel apprehensive that the upwards movement might, and certainly would if continued, curtail the foreign orders obtainable.

Write for this NEW booklet



GENERAL REFRACTORIES ARE THE SOLE MANUFACTURERS OF INSULITE AND AMBERLITE MATERIALS.

. . . . it contains information regarding insulation for every user of heat.

General Refractories manufacture three insulating products which are of vital importance to every user of heat. This new booklet describes these three products—Insulite and Amberlite bricks and Insulite Concrete—and also gives instances of how 80% of waste heat may be saved and fuel costs reduced by as much as 20% . . . these products may be used for the heat insulation of open hearth furnaces and regenerator chambers, blast furnace plant (including Cowper stoves), annealing and heat treatment furnaces, blast pipes, hot gas mains, etc., ceramic kilns and ovens, glass furnaces, boiler settings, economisers, and super-heaters, enamelling and general furnaces—whether heated by solid fuel, gas, oil or electricity. All the necessary technical information is also included, so we strongly advise that you write to-day for a free copy.

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Russell House, Adelphi, W.C.2
Telephone: Temple Bar 7361
Telegrams: "Genefax, Rand-London"

Scottish Office:
156, St. Vincent St., Glasgow
Telephone: 5250
Telegrams: "Genefax, Glasgow"

South Wales Office:
11, Wind St., Swansea
Telephone: 3680
Telegrams: "Genefax, Swansea"

MANUFACTURERS OF HEAT RESISTING AND HEAT INSULATING MATERIALS OF EVERY DESCRIPTION.

Raw Material Markets

Seasonal influences are beginning to show in the volume of new business, but most of the producing works have orders on their books sufficient to carry them well over the holiday period, and no inconvenience is caused by the temporary slackening of trade. The supply position as regards pig-iron is better, makers having made considerable progress in the overtaking of arrears of deliveries. The steelworks are active and a firm tone is maintained in all departments.

Pig-Iron

MIDDLESBROUGH.—Deliveries of pig-iron are more regular and the needs of consumers are being satisfied, but there is still little, if any, iron available for open market sales. Consumers are mostly covered well ahead, and, so long as deliveries come regularly to hand, are not very much concerned at the moment with securing further supplies. Producers, for their part, also are well booked ahead, and their output is going promptly into consumption. Firm conditions seem likely to rule for months ahead. Prices are unchanged, No. 3 Cleveland G.M.B. being at 75s. for use in the Middlesbrough or Falkirk areas, 77s. to consumers on the North-East Coast and 78s. on Clydeside. The hematite market also is firm. Supplies are moving away freely. Consumers' needs are being met, but there is little or no surplus. East Coast mixed numbers for home consumption are 85s. per ton in Scotland and on the North-East Coast, 90s. 6d. in Sheffield and 96s. in Birmingham, a rebate of 5s. per ton being allowed to purchasers who use only iron which is supplied by members of the Hematite Makers' Association.

LANCASHIRE.—There is not much new business being done in pig-iron in the Lancashire area, but there is a good demand from consumers and deliveries from the Midland furnaces are at a satisfactory level. Textile-machinery makers are still not so busy as they would like to be, but foundries associated with machine-tool making and heavy electrical engineering are active and are taking good quantities of pig-iron. General engineers and the light-castings establishments are also busy. Most consumers are booked well ahead. For delivery to users in the Lancashire price zone, current offers of Staffordshire and Derbyshire brands of No. 3 foundry iron are all on the basis of 83s. per ton, with Northamptonshire iron at 81s. 6d. and Derbyshire forge at from 78s. to 80s. per ton, according to the class of user. Scottish No. 3 foundry is quoted for delivery in the Manchester district at around 90s. per ton. West Coast hematite is at 93s. 6d. and East Coast 93s., less a rebate of 5s.

MIDLANDS.—Ironfounders in the Midlands are well situated for work and there is a steady call on the furnaces for supplies. Coke is still a difficulty, but production will require to be increased if consumption remains on the present scale, otherwise a shortage of iron is not unlikely. There is not a great deal of new business about at the moment, due to the fact that consumers are booked ahead, but makers are well situated for orders. Current prices, including delivery to Birmingham and Black Country stations, are 77s. 6d. for Northants No. 3 and 80s. for Derbyshire, Lincolnshire and North Staffordshire No. 3, less a small sliding scale rebate to the large foundries. It is anticipated that these rates will be maintained for some time.

SCOTLAND.—The works in Glasgow and district are closed this week for the Fair holidays, and pig-iron requirements are thus reduced. The Falkirk works, however, are operating and are very busy. There is no alteration in market quotations, No. 3 Scottish foundry remaining at 79s. f.o.t. furnaces, with 2s. 6d. per ton extra for No. 1. Official quotations for No. 3 Cleveland are 75s. f.o.t. Falkirk and 78s. f.o.t. Glasgow district. Steel-making pig-irons are unchanged as follow :—Mixed numbers East Coast, West Coast and Scottish hematite, 85s. 6d., less 5s. rebate; basic, British and Indian, 75s., less 5s. rebate, delivered steelworks.

Coke

The coke market retains its firm tone, and there is little sign this year of the usual seasonal easing of prices, which generally are well maintained. Durham foundry coke realises 24s. 6d. and furnace coke 21s. 6d., at ovens. For delivery in Birmingham district, best Durham foundry coke is quoted at between 41s. 6d. and 43s., with other grades down to 39s. Welsh foundry coke ranges from 39s. 6d. up to 50s., delivered South Staffs stations.

Steel

With the opening of the holiday period the volume of new business has shown signs of declining, but this is a seasonal movement, and most of the steelworks have sufficient orders on their books to keep them busy until the end of the year. It is expected that the demand will gain fresh strength when the holiday season is over, and some consumers seem to fear that a stringency will develop in the market later in the year. In the semi-finished steel department the works are producing at capacity; but are unable to keep pace with the demand. The position, however, is better than a few weeks ago owing to the increased production, and there are fewer complaints by consumers of late deliveries. New business in finished steel has been quiet; but production continues almost at a record rate in several departments. There is no relaxation in the quantities of structural material passing into consumption, but the greater part of it is being used for home requirements. Export business of late has shown signs of expanding, but its development is slow.

Scrap

There is little change in conditions in the scrap markets, which at the moment are rather quiet. Reports from the Cleveland area show that trade in steel scrap is somewhat restricted, but the demand for machinery and heavy foundry metal is still fairly active and the recent advance in prices has been maintained, good machinery metal commanding a delivered price of 67s. 6d. and ordinary heavy foundry cast iron 65s. per ton. Heavy cast iron has a moderate demand in the South Wales area, and a fair amount of business has been done at 58s. to 60s. Light cast iron continues to have a ready sale at 52s. 6d. to 53s. 6d. Good cast-iron machinery scrap for foundry purposes is quiet in South Wales at 62s. 6d. to 64s. In the Midlands there is a steady demand for cast scrap at firm prices. Heavy machinery metal in cupola sizes is at 70s., good heavy pipe and plate at 65s. and clean light at 52s. 6d. to 55s., delivered works. Heavy machinery cast-iron scrap is, if anything, a little easier in Scotland, and it is sometimes difficult to obtain 68s. 6d. to 70s. Heavy ordinary cast-iron scrap is around 65s., delivered consumers' works.

Metals

Copper.—A buying movement in copper, stimulated by a strong demand from consumers and reports of a possible increase in the United States domestic price, which has since taken place, resulted in higher quotations on the London Metal Exchange. World stocks have been further reduced, the unofficial figures for June showing a drop of 7,300 tons, and this was a further bull point for the metal. The increase in the United States is from 9½ cents to 9¾ cents per lb.

Daily market prices :—

Cash.—Thursday, £37 to £37 2s. 6d.; Friday, £37 to £37 2s. 6d.; Monday, £37 11s. 3d. to £37 12s. 6d.; Tuesday, £37 15s. to £37 16s. 3d.; Wednesday, £37 13s. 9d. to £37 15s.

Three Months.—Thursday, £37 6s. 3d. to £37 7s. 6d.; Friday, £37 6s. 3d. to £37 7s. 6d.; Monday, £37 17s. 6d. to £37 18s. 9d.; Tuesday, £38 1s. 3d. to £38 2s. 6d.; Wednesday, £38 to £38 1s. 3d.

Tin.—An increase in tin prices inspired by the improved sentiment in other metals was not wholly retained, and the market remains uncertain. There are no new developments in connection with the renewal of the restriction scheme. The Siamese attitude still remains the stumbling-block, and two representatives of the International Tin Committee are now at Bangkok conferring with the authorities there. Consumption is maintained on a fair scale, but in the absence of definite agreement on production levels after the end of this year, fluctuating prices must be expected for some time.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £189 10s. to £190; Friday, £187 5s. to £187 10s.; Monday, £190 10s. to £192; Tuesday, £189 10s. to £189 15s.; Wednesday, £189 15s. to £190 5s.

Three Months.—Thursday, £184 15s. to £185; Friday, £183 2s. 6d. to £183 5s.; Monday, £187 10s. to £188; Tuesday, £186 to £186 5s.; Wednesday, £187 to £187 10s.

Spelter.—Prices have risen, a gain of about 10s. being recorded on the week. Mostly this has been in sympathy with the movement of other metals, as actually the position of spelter is not greatly changed. There have been reports of progress in the Cartel negotiations, but nothing definite is known, and meanwhile a dull tone persists. A better turnover has, however, been seen this week.

Official quotations were as follow :—

Ordinary.—Thursday, £13 8s. 9d.; Friday, £13 8s. 9d.; Monday, £13 13s. 9d.; Tuesday, £13 18s. 9d.; Wednesday, £13 17s. 6d.

Lead.—The demand is very good and the market has gained strength during the week. The arrival of a large shipment of lead from Mexico widened the contango temporarily, but, notwithstanding that supplies seem likely to remain heavy, a good tone is maintained, and prices have risen. Demand is extensive all round, but particularly in this country, where building activity has again strengthened the market.

Day-to-day quotations :—

Soft foreign (prompt).—Thursday, £15 10s.; Friday, £15 12s. 6d.; Monday, £16 2s. 6d.; Tuesday, £16 10s.; Wednesday, £16 12s. 6d.

New Chemical Standard

"L" AUSTENITIC IRON

Bureau of Analysed Samples, Limited, which has recently taken over from Messrs. Ridsdale & Company, Limited, the preparation and supply of British Chemical Standards, announces the issue of the second of a series of alloy cast irons containing special elements. This standard analysed sample is typical of a type sometimes known as Ni-resist irons, which are now being used both for electrical-resistance grids and purposes for which high resistance to corrosion at ordinary temperatures and scaling and growth at high temperatures is essential.

The standard sample presented more difficulties in analysis than was anticipated, and should be useful to chemists who need more information about the accurate determination of high Ni-Cr and Cu and their effect on the determination of the ordinary elements in cast iron. The standard turnings have been carefully analysed as usual by a number of experienced chemists representing the different interests involved, viz., the British Cast Iron Research Association, independent analysts, and makers and users of this class of iron.

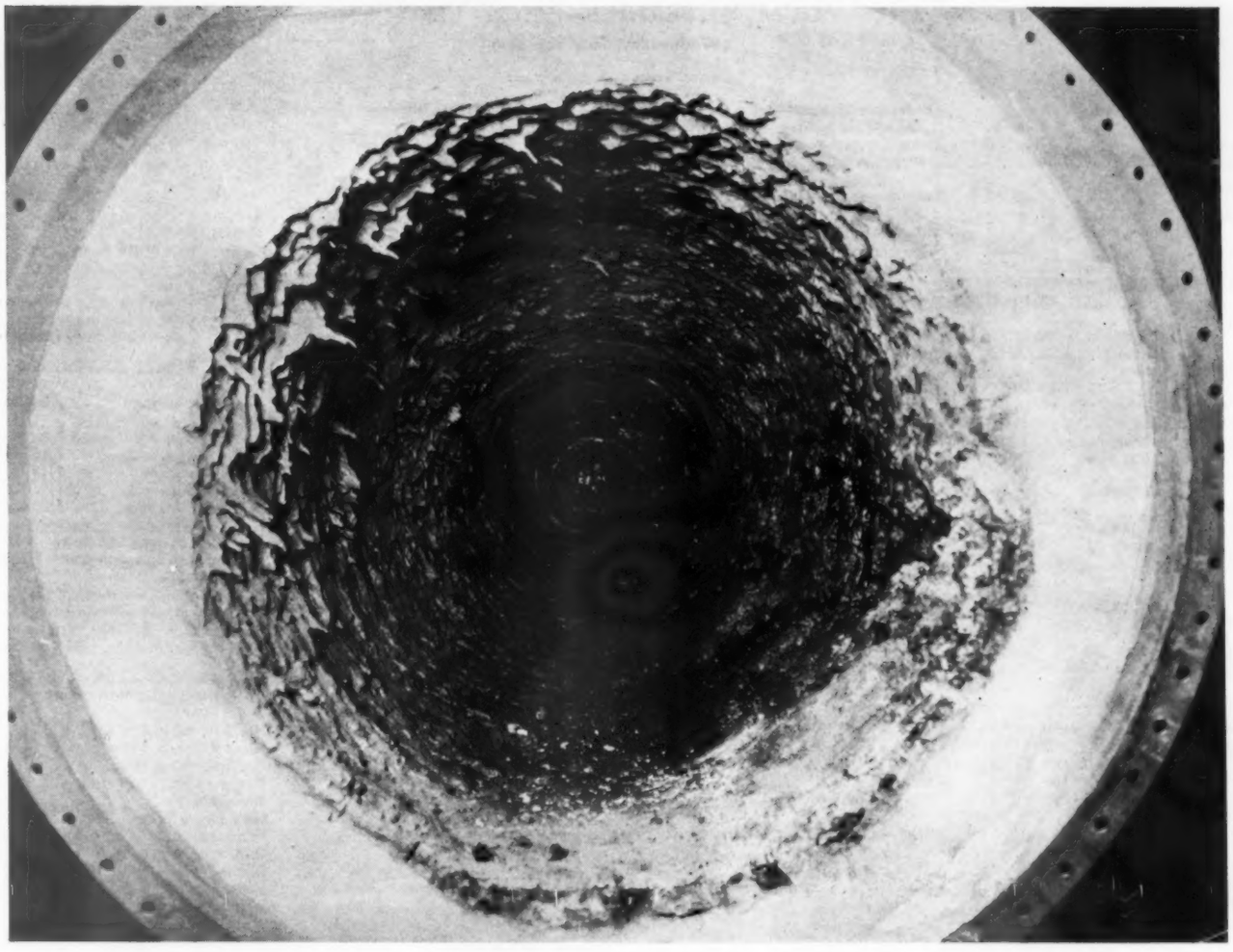
The standardised figures are as follow (per cent.):—Total carbon, 3.06; silicon, 2.26; manganese, 1.01; sulphur, 0.031; phosphorus, 0.119; nickel, 13.45; chromium, 3.96; and copper, 4.73.

This is probably the only standard of its kind in Great Britain and is therefore likely to be of interest to independent chemists, government chemists and works chemists associated with the manufacture or use of alloy irons in the aviation, motor, engineering and electrical industries.

The standard is issued in bottles containing 500, 100, 50 and 25 grms. each at a price which is estimated to cover the cost. Each bottle is provided with a certificate showing each chemist's analysis, together with an outline of the methods he used. The standard may be obtained from Bureau of Analysed Samples, Limited, 3, Wilson Street, Middlesbrough, or from any of the usual laboratory furnishers.

The Fe-Cr-C System

The Fe-Cr-C system with up to 70 per cent. Cr and with C contents up to the intersection of the Fe_3C and Cr_7C_3 diagrams has been studied by W. TOPAUTE and his collaborators, a report of this work forming the subject of Report No. 343 of the materials committee of the Verein deutscher Eisenhüttenleute, published in the "Archiv für das Eisenhüttenwesen." The results are shown in phase diagrams and compared with those of previous authors.



950 tons of metal melted—

The above photograph shows the condition of an 04 grade Albino lining in a 5-ton Brackelsberg furnace after 255 heats. You will observe the lining has worn dark evenly and it is still approximately 8" in thickness. The 04 grade is specially produced for rotary furnaces, but there are other grades for lining cupolas, converters and ladles. These photographs are reproduced by courtesy of James Howden and Company (Land) Ltd.

ALBINO

ROTARY FURNACE LINING MATERIAL

Please write for further particulars to the sole manufacturers :

GENERAL REFRACTORIES LIMITED,

Genefax House, Sheffield, 10

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MANUFACTURERS OF HEAT RESISTING AND HEAT INSULATING MATERIALS OF EVERY DESCRIPTION.

RAW MATERIALS—PRICE LIST

(Wednesday, July 22, 1936)

COPPER

	£ s. d.
Standard cash	37 13 9
Three months	38 0 0
Electrolytic	42 0 0
Tough	40 10 0
Best selected	41 0 0
Sheets	68 0 0
India	50 10 0
Wire bars	42 0 0
Ingot bars	42 0 0
H.C. wire rods	45 10 0
Off. av. cash, June	36 7 2½
Do., 3 mths., June	36 13 0¼
Do., Sttlmnt., June	36 6 10½
Do., Electro, June	40 11 3
Do., B.S., June	39 19 2
Do., wire bars, June	40 15 4½
Solid drawn tubes	10½d.
Brazed tubes	10½d.
Wire	6½d.

BRASS

Solid drawn tubes	9½d.
Brazed tubes	11½d.
Rods, drawn	8½d.
Rods, extd. or rlld.	8d.
Sheets to 10 w.g.	7d.
Wire	7½d.
Rolled metal	7½d.
ellow metal rods	5d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN

	£ s. d.
Standard cash	189 15 0
Three months	187 0 0
English	189 15 0
Bars	190 10 0
Straits	193 10 0
Australian (nom.)	—
Eastern	190 7 6
Banca	192 0 0
Off. av. cash, June	183 6 10½
Do., 3 mths., June	181 1 2½
Do., Sttlmt., June	183 5 8½

SPELTER

	£ s. d.
Ordinary	13 17 6
Remelted	13 10 0
Hard	11 10 0
Electro 99.9	15 18 9
English	14 17 6
India	12 15 0
Zinc dust	19 10 0
Zinc ashes	4 5 0
Off. aver., June	14 0 2½
Aver. spot, June	13 17 11

LEAD

	£ s. d.
Soft foreign ppt.	16 12 6
Empire	17 5 0
English	18 10 0
Off. average, June	15 4 3½
Average spot, June	15 3 4½

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

Zinc sheets, English	23 10 0 to 24 0 0
Do., V.M. ex-whse.	23 10 0 to 24 0 0
Rods	26 0 0

ANTIMONY

English	64 10 0 to 65 10 0
Chinese, ex-whse.	49 0 0
Crude, c.i.f.	24 0 0

QUICKSILVER

Quicksilver	11 7 6 to 11 17 6

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	8 17 6
45/50%	12 15 0
75%	17 17 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
20/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	33 0 0
4/6% car.	21 10 0
6/8% car.	21 0 0
8/10% car.	21 0 0
Ferro-chrome—	
Max. 2% car.	33 10 0
Max. 1% car.	36 5 0
Max. 0.50% car.	37 5 0
70% carbon-free	9½d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	6/3 to 6/9 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese—	
76/80% loose	£11 5 0 to 11 15 0
76/80% packed	£12 5 0 to 12 15 0
76/80% export	(nom.) £10 5 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	3 2 6	to 3 3 0
Mixed iron and steel	2 18 0	to 3 0 0
Heavy cast iron	2 18 0	to 3 0 0
Good machinery	3 2 6	to 3 4 0
Cleveland—		
Heavy steel	2 17 6	
Steel turnings	2 0 0	
Heavy cast iron	3 5 0	
Heavy machinery	3 7 6	
Midlands—		
Light cast-iron scrap	2 12 6	to 2 15 0
Heavy wrought iron	3 7 6	
Steel turnings	2 0 0	
Scotland—		
Heavy steel	2 17 6	
Ordinary cast iron	3 5 0	
Engineers' turnings	2 1 3	
Cast-iron borings	1 17 6	
Wrot-iron piling	3 9 6	
Heavy machinery	3 8 6	to 3 10 0

London—Merchants' buying prices, delivered yard.

Copper (clean)	29 0 0
Brass	19 0 0
Lead (less usual draft)	14 5 0
Tea lead	9 0 0
Zinc	8 0 0
New aluminium cuttings	74 0 0
Brazierv copper	27 0 0
Gunmetal	28 0 0
Hollow pewter	130 0 0
Shaped black pewter	100 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	77/6
,, No. 3	75/-
,, No. 4	74/-
Forge No. 4	74/-
Hematite No. 1	85/6*
Hematite M/Nos.	85/-*
N.W. Coast—	
Hem. M/Nos. d/d Glas.	85/6*
,, d/d Birm.	97/-*
Malleable iron d/d Birm.	125/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	77/-
,, No. 3 fdry.	80/-
Northants forge	74/6
,, fdry. No. 3	77/6
,, fdry. No. 1	80/6
Derbyshire forge	77/-
,, fdry. No. 3	80/-
,, fdry No. 1	83/-
Scotland—	
Foundry, No. 1, f.o.t.	81/6
,, No. 3, f.o.t.	79/-
Cleveland No. 3, Glasgow	78/-
,, ,, Falkirk	75/-
Scottish hem. M/Nos. d/d	85/6*
Sheffield (d/d district)—	
Derby forge	74/6
,, fdry. No. 3	77/6
Lincs forge	74/6
,, fdry. No. 3	77/6
W.C. hematite	91/-*
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	83/-
Staffs fdry. No. 3	83/-
Northants fdry. No. 3	81/6
Cleveland fdry. No. 3	83/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	90/-
Clyde, No. 3	90/-
Monkland, No. 3	90/-
Summerlee, No. 3	90/-
Eglinton, No. 3	90/-
Gartsherrie, No. 3	90/-
Shotts, No. 3	90/-

* Subject to a rebate of 5s. per ton under certain conditions

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	10 2 6	
Nut and bolt iron	8 10 0	to 9 0 0
Hoops	11 0 0	and up.
Marked bars (Staffs) f.o.t.	12 10 0	
Gas strip	11 0 0	and up.
Bolts and nuts, ¾ in. × 4 in.	15 15 0	and up.
Steel—		
Plates, ship, etc.	9 7 6	to 9 10 0
Boiler plts.	9 17 6	to 10 0 0
Chequer plts.	11 0 0	
Angles	9 0 0	
Tees	10 0 0	
Joists	9 7 6	
Rounds and squares, 3 in. to 5½ in.	10 0 0	
Rounds under 3 in. to ¼ in. (Untested)	9 7 0	
Flats—8 in. wide and over	9 5 0	
,, under 8 in. and over 5 in.	9 10 0	
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 10 0	
Hoops (Staffs)	10 2 0	
Black sheets, 24g. (4-t. lots)	11 10 0	
Galv. cor. shts. (,,)	13 10 0	
Galv. flat shts. (,,)	14 0 0	
Galv. fencing wire, 8g. plain	15 0 0	
Billets, soft	6 2 6	
Billets, hard	7 2 6	to 7 7 6
Sheet bars	6 0 0	
Tin bars	6 0 0	

PHOSPHOR BRONZE

	Per lb. basis
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	12½d.
Rods	11½d.
Tubes	14d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	21.31
No. 2 foundry, Valley	19.50
No. 2 foundry, Birm.	15.50
Basic, Valley	19.00
Malleable, Valley	19.50
Grey forge, Valley	19.00
Ferro-mang. 80%, seaboard	75.00
O.-h. rails, h'y, at mill	36.37½
Billets	30.00
Sheet bars	30.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.95
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.80
Steel hoops	1.95
Sheets, black, No. 24	2.50
Sheets, galv., No. 24	3.20
Wire nails	2.10
Plain wire	2.40
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	30/- to 31/-
,, furnace	24/6 to 25/-
Durham foundry	24/6
,, furnace	21/6
Scotland, foundry	30/-
,, furnace	25/- to 26/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	18/9
,,	28×20 ,,	37/6
,,	20×10 ,,	26/9 to 27/-
,,	18¾×14 ,,	19/6
C.W.	20×14 ,,	15/6 to 15/9
,,	28×20 ,,	33/9 to 34/-
,,	20×10 ,,	22/6 to 22/9
,,	18¾×14 ,,	15/3 to 15/9

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£6 0 0 to £7 0 0
Bars-hammered, basis	£16 0 0 to £16 10 0
Bars and nail-rods, rolled, basis	£15 15 0 to £16 0 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£30 0 0 to £31 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£	s.	d.		
July 16 ..	37	0	0	inc.	1/3
„ 17 ..	37	0	0	No	change
„ 20 ..	37	11	3	inc.	11/3
„ 21 ..	37	15	0	„	3/9
„ 22 ..	37	13	9	dec.	1/3

Electrolytic Copper

	£	s.	d.		
July 16 ..	41	2	6	inc.	2/6
„ 17 ..	40	17	6	dec.	5/-
„ 20 ..	41	10	0	inc.	12/6
„ 21 ..	41	17	6	„	7/6
„ 22 ..	42	0	0	„	2/6

Standard Tin (cash)

	£	s.	d.		
July 16 ..	189	10	0	dec.	60/-
„ 17 ..	187	5	0	„	45/-
„ 20 ..	190	10	0	inc.	65/-
„ 21 ..	189	10	0	dec.	20/-
„ 22 ..	189	15	0	inc.	5/-

Tin (English ingots)

	£	s.	d.		
July 16 ..	189	15	0	dec.	55/-
„ 17 ..	187	5	0	„	50/-
„ 20 ..	191	0	0	inc.	75/-
„ 21 ..	189	10	0	dec.	30/-
„ 22 ..	189	15	0	inc.	5/-

Spelter (ordinary)

	£	s.	d.		
July 16 ..	13	8	9	No	change
„ 17 ..	13	8	9	„	„
„ 20 ..	13	13	9	inc.	5/-
„ 21 ..	13	18	9	„	5/-
„ 22 ..	13	17	6	dec.	1/3

Spelter (Electro, 99.9 per cent.)

	£	s.	d.		
July 16 ..	15	7	6	dec.	1/3
„ 17 ..	15	8	9	inc.	1/3
„ 20 ..	15	11	3	„	2/6
„ 21 ..	15	18	9	„	7/6
„ 22 ..	15	18	9	No	change

Lead (soft foreign, prompt)

	£	s.	d.		
July 16 ..	15	10	0	inc.	2/6
„ 17 ..	15	12	6	„	2/6
„ 20 ..	16	2	6	„	10/-
„ 21 ..	16	10	0	„	7/6
„ 22 ..	16	12	6	„	2/6

Lead (English)

	£	s.	d.		
July 16 ..	17	10	0	No	change
„ 17 ..	17	15	0	inc.	5/-
„ 20 ..	18	5	0	„	10/-
„ 21 ..	18	10	0	„	5/-
„ 22 ..	18	10	0	No	change

Imports and Exports of Pig-Iron and Steel Castings, etc., in June, and the Six Months 1936, compared with June, and the Six Months 1935.

	June.		Six months.		June.		Six months.	
	1935.	1936.	1935.	1936.	1935.	1936.	1935.	1936.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Imports.								
Pig-iron—from British India	6,311	9,814	38,925	44,506	21,187	30,715	117,990	138,796
„ Foreign Countries	1,785	2,754	7,334	21,062	10,444	14,207	43,065	98,620
Total	8,096	12,568	46,259	65,568	31,631	44,922	161,055	237,416
Castings and forgings	41	709	1,355	4,317	1,206	23,964	35,611	145,419
Cast pipes and fittings	321	49	619	591	4,668	2,284	17,719	22,239
Stoves and grates, etc.	81	46	529	344	7,327	4,601	48,508	37,967
Baths	575	413	3,290	3,223	14,845	10,568	89,128	81,514
Hollow-ware, all kinds	250	406	1,274	1,747	15,205	19,332	85,305	95,508
Exports.								
Pig-iron, forge and foundry	7,535	5,051	46,974	27,746	26,007	19,675	164,463	107,218
„ acid	3,024	2,026	26,279	16,305	10,324	7,472	85,460	56,861
„ basic	—	—	231	108	—	—	727	557
Total	10,559	7,077	73,484	44,159	36,331	27,147	250,650	164,636
Castings and forgings	360	293	2,054	2,129	16,085	11,444	80,678	79,702
Cast pipes and fittings, up to 6 in. diameter	5,967	3,432	27,977	26,861	63,522	40,072	309,321	303,023
„ „ „ over 6 in.	3,462	2,380	19,536	20,359	25,477	19,460	149,598	166,421
Stoves, grates, etc.	670	737	4,128	4,962	35,361	40,450	204,533	254,992
Sanitary cisterns	264	233	1,529	1,504	7,808	7,345	43,577	47,387
Bedsteads, including tubes therefor	310	315	2,185	2,382	11,267	12,314	78,594	89,493
Cast hollow-ware	266	405	1,886	2,658	10,592	16,675	73,554	94,739

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

PIG IRON
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LIMPET

FOR EVERY TYPE OF CASTING

NON-FERROUS METALS

REFRACTORIES — COKE — SAND
FERRO-SILICON—FERRO-CHROME

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ZETLAND ROAD, MIDDLESBROUGH.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

FOUNDRYMAN, practical, technical and commercial experience, wishes to represent first-class firm for sale of ferrous and non-ferrous castings in Birmingham and Midlands.—Box 808, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

METALLURGICAL Chemist, age 22, desires an appointment. Experience of ferrous or non-ferrous work. Excellent references.—Apply L. T. BEVERLEY, "Rutland," Elsma Road, Quinton, Birmingham.

METALLURGIST, B.Sc., 24 years, desires change. Four years' apprenticeship. Sound knowledge of cupola control, alloy irons and general foundry practice, etc. Desires position as Assistant Foundry Manager, Metallurgist or on foundry sales.—Box 814, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Chemist required. Apply stating age, experience, and salary required, to PEGLERS, LIMITED, Doncaster.

FOUNDRY Superintendent for North-East Coast. Light castings, pipes, etc. Only those with wide experience of modern methods need apply. State age, experience, and salary required, to Box 802, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

METALLURGIST wanted to take charge of high-frequency melting plant on alloy steels. Preferably with some foundry experience. Excellent prospects for the right man. Applications, which will be treated in confidence, should give particulars of training and experience, age, and salary required, to Box 818, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED.—Manager for Jobbing Ironfoundry in the Manchester area. Must have experience in light and heavy castings, and of cupola control. State experience, salary required, and when would be free to commence duties.—Apply Box 816, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

FOUNDRY Manager requires position or as Assistant. Young, practical moulder, excellent experience in managerial positions on general engineering and also repetition work. Cupola control. Sound technical training. (281)

SITUATIONS VACANT AND WANTED.—*Contd.*

MANAGER, age 40, practically and metallurgically highly qualified Engineer with 15 years' experience in large iron, steel, brass and aluminium foundries, desires responsible position with well reputed firm. (282)

IRONFOUNDRY Foreman desires position with progressive firm. Experienced in jobbing work, machine moulding, general engineering, estimating, cupola practice, etc. (283)

MACHINERY

WANTED.—Rotary Melting Furnace, 1 ton capacity. Also power Riddling Machine.—Box 800, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

Tilghman Sandblast Barrel Plants; barrel sizes—60 in. x 40 in.; 36 in. x 20 in.; 20 in. x 30 in.

Tilghman Sandblast Cabinet Plants; 4 ft. 6 in. and 3 ft. 6 in. square (one for high pressure 70 lbs. per sq. in.); also small Cabinet 30 in. dia.

All complete with Air Compressors, etc.

Gas and Air Mixer by Sharpe & Preston, 2-in. outlet.

Six Osborne Pneumatic Jolt Press Moulding Machines, size 75J.

Three Mumford Yoke Headpress Pneumatic Moulding Machines.

Two Herbert Whizzer Sand Disintegrators.

Two Brealey Type ditto.

Heavy Double-ended Grinding Machines by Rowlands, Luke & Spencer, etc.

Hand Moulding Machines by Adaptable Darling & Sellars, Pridmore, Samuelson, etc.

500 Electric Motors, Dynamos, Rotary Converters, etc.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.
CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

THOS. W. WARD LTD.

One "Pridmore" Pneumatic MOULDING MACHINE; type "EVE"; to take boxes 1′ 9″ x 2′ 6″.

Rateau patent TURBO-BLOWERS (Fraser & Chalmers) for 35,000 cub. ft. per min. at 14 lbs. pressure.

Nearly new high-class STEAM TRACTOR VERT. BOILER; about 5′ 6″ high x 2′ 10½″ dia.; 250 lbs. w.p.

Write for "Albion" Catalogue.

'Grams: "Forward." 'Phone: 23001 (10 lines).
ALBION WORKS, SHEFFIELD.

MISCELLANEOUS

REQUIRED. — Sandblast Cabinet, size approximately 5 ft. by 2 ft., complete with hopper, suitable for sand at 30 lbs. pressure.—Box 820, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FLUIDITY TESTS as described in THE FOUNDRY TRADE JOURNAL, February 1, 1934. Patterns of the above in aluminium can be supplied for 35s. per set. Post free. We can also supply Patterns for all branches of the engineering trade, in hard or soft woods. Send us your inquiries. — FURMSTON & LAWLOR, Patternmakers, Letchworth, Herts.

MISCELLANEOUS—*Continued*

TRY Southport Sand, the best for Cores. Quick deliveries by road. Any quantity. Sample free.

JOHN LIVESEY,
SAND MERCHANT,
SOUTHPORT.

'Phone: 287 SLOUGH

MOULDING MACHINES

Two Tabor Modern Jolt Squeeze and Pattern Draw Machines for boxes 20″ × 14″; as new. Price £65 each.

One ditto, for 20″ square Boxes. Price £70.

Several reconditioned GRIMES Hand Pattern-draw and Turnover Machines. Price £12 each.

One genuine OSBORN Hand Machine. Price £28.

Several nearly new DENBIGH Jolters. CHEAP!

CUPOLETTE, 30″ dia., NEW. Price £26.

PLEASE SEND US YOUR ENQUIRIES.

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH
BUY FROM ME AND SAVE MONEY!

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SANDBLAST
THINK OF
RICHARDSON'S
Established 1887.

We Supply Re-Conditioned & New
SAND BLAST PLANTS
AND
AIR COMPRESSORS.

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